

## Practical Exam in Biology

## בחינת בגרות מעשית בביולוגיה

### Problem 1

בעיה 1

יש לרשום את מספר תעודת הזהות שלך כאן:

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### Instructions:

### הוראות:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:

ב. חומר עזר מותר בשימוש:

(1) Calculator

(1) מחשבון

(2) Hebrew–foreign language / foreign language–  
Hebrew dictionary

(2) מילון עברי–לועזי / לועזי–עברי

ג. Special instructions:

ג. הוראות מיוחדות:

(1) Read the instructions carefully and think  
carefully before each step.

(1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב  
את הצעדים.

(2) Write all of your observations and answers in  
pen (including sketches).

(2) יש לרשום בעט את כל התצפיות והתשובות (גם  
סרטוטים).

(3) Base your answers on your observations and  
the results you obtained, even if they are not as  
expected.

(3) יש לבסס את התשובות על תצפיותיכם ועל  
התוצאות שקיבלתם, גם אם הן אינן תואמות את  
הצפוי.

Write in the answer booklet only. Write the word  
"טיוטה" at the top of each page you use as a draft  
page. If you write any draft material outside the exam  
booklet, your exam may be disqualified.

יש לכתוב במחברת הבחינה בלבד. יש לרשום "טיוטה"  
בראש כל עמוד המשמש טיוטה. כתיבת טיוטה בדפים  
שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

## Problem 1

**In this problem, you will be testing the activity of the urease enzyme in soy seeds.**

The questions in this exam are numbered **1–12**. The point value of each question is listed on the left of each question.

Answer all of the questions in your answer booklet.

### Part א – Testing for the presence of proteins in soy seeds

In this part of the exam, you will be testing for the presence of proteins in soy seeds.

You will conduct the test using two solutions: a basic solution of sodium hydroxide (NaOH), which is colorless and a solution of copper sulfate ( $\text{CuSO}_4$ ), which is light blue. In the presence of a mixture of these two solutions, the color of a liquid that contains proteins will change to purple.

On the table, you have:

- a mortar and pestle; the mortar contains 5 swollen soy seeds
- a test tube containing boiled soy filtrate, labeled "תסנין מורתח"
- a container of distilled water labeled "מים מזוקקים"
- a basic solution of sodium hydroxide (NaOH). Caution! Avoid skin contact with this basic solution.
- a 2% solution of copper sulfate ( $\text{CuSO}_4$ )
- a spoon

Put on the gloves and safety goggles.

#### Step א1: Preparing swollen soy seeds filtrate

- Use a glass marking pen to write "תסנין" [filtrate] on an empty test tube.  
Mark a line on the test tube, 10 cm from the bottom of the test tube.
- On the table, you have a funnel and a folded piece of gauze. Line the funnel with the piece of gauze and insert the tip of the funnel into the test tube labeled "תסנין".  
Place the test tube in the test tube rack.
- Use the pestle to slightly crush the seeds in the mortar.
  - Write "מים" on a 10 ml pipette, and use this pipette to add 10 ml of water to the mortar from the container labeled "מים מזוקקים".
  - Crush the seeds for about two minutes.
- Add another 10 ml of water to the mortar and crush for one more minute until you have a pulp.
  - Use the spoon to transfer all the pulp and liquid from the mortar to the gauze in the funnel, and wait until a filtrate is obtained in the test tube.
  - Gather the edges of the gauze and squeeze it to filter the remaining liquid into the test tube. The volume of filtrate should reach the line you marked on the test tube or above it.
  - If the volume of the filtrate does not reach the line you marked on the test tube, squeeze the gauze again.
- Transfer the funnel and the gauze with the remaining seed residue to the mortar.

Step 2: Testing the presence of proteins in soy seeds filtrate and in boiled filtrate

- א. There are three empty test tubes in the rack. Label them 1, 2, and 3.  
These test tubes will be used to test for the presence of proteins in the solutions: Test Tube 1 to test the filtrate, Test Tube 2 to test the boiled filtrate, and Test Tube 3 to test water.
- ב. Write "תסנין" on a 5 ml pipette.
  - Use it to transfer 1 ml of filtrate from the "תסנין" test tube to Test Tube 1.
- ג. Write "תסנין מורח" on a 5 ml pipette.
  - Use it to transfer 1 ml of boiled filtrate from the "תסנין מורח" test tube to Test Tube 2.
- ד. Use the pipette labeled "מים" to transfer 1 ml of distilled water to Test Tube 3.
  - Add 5 drops of the basic NaOH solution to each of the three experimental test tubes, 1–3.
  - Add 5 drops of the  $\text{CuSO}_4$  solution to each of the three experimental test tubes.
  - Mix the contents of each of the test tubes by shaking them gently, then check the color of the solution in each of the test tubes.

Answer Questions 1-3.

- (6 points) 1. **Copy** the table below into your **answer booklet** and fill in the missing information. Determine whether proteins were present in the solutions, based on the information listed in the introduction to Part א.

**Table 1: Testing for the presence of proteins in the solutions**

| Test tube | Tested solution | Test result<br>(Color) | Presence of proteins<br>(Yes/No) |
|-----------|-----------------|------------------------|----------------------------------|
| 1         |                 |                        |                                  |
| 2         |                 |                        |                                  |
| 3         |                 |                        |                                  |

- (3 points) 2. Explain why the test you conducted in Test Tube 3 is important.
- (4 points) 3. Is it possible to determine the protein concentration in the soy filtrate in Test Tube 1, based on the test you conducted? Explain.

**Place Test Tubes 1–3 in the waste container on your table.**

## Part 1 – Experiment: Testing the activity of the urease enzyme in soy seeds filtrate

The compound **urea** is a product of metabolic processes in living cells.

Various organisms (including the soy plant) contain the **urease** enzyme which catalyzes the breakdown of urea.

One of the products of urea breakdown is ammonia ( $\text{NH}_3$ ) which, in an aqueous environment, combines with water and forms a basic substance: **ammonium hydroxide**.

### Step 1: Preparing dilutions of urea solution

On the table, you have:

- a test tube with urea solution labeled "1% אוראה"
- a dropper bottle containing the indicator "פנול אדום" [phenol red]
- a solution of hydrochloric acid ( $\text{HCl}$ ). Caution! Avoid skin contact with the acid solution.
- a Pasteur pipette

י. Label 5 empty test tubes: א–ה.

- Write "אוראה" on a 1 ml pipette and use it to transfer urea solution to Test Tubes ב–ה, according to the information shown in Table 2 below.

**Do not add urea solution to Test Tube א.**

יא. Write "מים" on a 1 ml pipette and use it to transfer water to Test Tubes א–ג, according to the information shown in Table 2.

- Mix the contents of the test tubes by shaking them gently.

**Table 2**

| Test Tube | Volume of<br>1% urea solution<br>(ml) | Volume of water<br>(ml) |
|-----------|---------------------------------------|-------------------------|
| א         | 0                                     | 1                       |
| ב         | 0.1                                   | 0.9                     |
| ג         | 0.3                                   | 0.7                     |
| ד         | 1                                     | 0                       |
| ה         | 1                                     | 0                       |

### Step 2: Testing the activity of urease enzyme in the filtrate

יב. Use the pipette labeled "תסנין מורתח" to add 3 ml of **boiled** filtrate to Test Tube ה.

יג. **Cap** the "תסנין" test tube **tightly**, and mix the liquid in the test tube by turning the test tube upside-down twice.

- Use the "תסנין" pipette to add 3 ml of filtrate from the "תסנין" test tube to each of the four test tubes א–ד.
- Gently shake each of the test tubes and put them back in the test tube rack.
- Write down the time \_\_\_\_\_ and wait 3 minutes.

While you are waiting, read Items יד–טו (without carrying out any action) and the information in the box labeled "Note 1".

- יד. 3 minutes after the time you recorded in Item יג, add one drop of phenol red to each of the five test tubes א–ה, and gently shake the test tubes.

**Note 1**

In the experiment you are about to conduct, phenol red is an indicator that is red-pink in a basic environment and yellow-orange in an acidic environment.

- טו. Based on the information provided in Note 1, write for each of the solutions in the test tubes א–ה whether it is basic or acidic:

Test Tube א \_\_\_\_\_, Test Tube ב \_\_\_\_\_, Test Tube ג \_\_\_\_\_, Test Tube ד \_\_\_\_\_, Test Tube ה \_\_\_\_\_.

During the following steps of the experiment, you will use the solution of hydrochloric acid ( $\text{HCl}$ ) that is on the table. The acid will react with the ammonium base that was formed in the solutions.

**Note 2**

The greater the amount of base formed in the solution, the greater the amount of acid required to neutralize the base and change the color of the phenol red indicator.

**Read the instructions in Items יז–יט before you start carrying them out.** You will have to **gradually** add drops of acid to each of the solutions in Test Tubes א–ה, and **count** the drops.

Work carefully and accurately.

- יז. Write "חומצה" on the Pasteur pipette that is on the table.
- Take Test Tube א out of the test tube rack and use the Pasteur pipette to add one drop of the acid  $\text{HCl}$ . The color of the solution in the test tube will turn light yellow.
  - Put Test Tube א back in the test tube rack.
- יח. Take Test Tube ב out of the test tube rack. Add acid drop by drop to the test tube and shake the test tube after each drop. **Count the drops** until the solution in Test Tube ב remains a stable light yellow for 10 seconds – **the color should be as close as possible to the color of the solution in Test Tube א**. Put the test tube back in the test tube rack.
- Write how many drops you added into Test Tube ב: \_\_\_\_\_ drops.

Note: After you put the test tube back in the test tube rack, the solution in the test tube may change color. **Ignore** this change.

- יט. Repeat the procedure described in Item יח with test tubes ג, ד, ה.
- Write how many drops you added to Test Tube ג: \_\_\_\_\_ drops,  
to Test Tube ד: \_\_\_\_\_ drops,  
to Test Tube ה: \_\_\_\_\_ drops.

You do not need gloves and safety goggles for the rest of the exam, so you can take them off now.

Answer Questions 4–8.

- (6 points) 4. **Calculate** the concentration of the urea solution in each of the test tubes א–ה after you added the filtrate (in Items יב–יג).

Note: The concentration of the urea solution that you used is 1 %, and the final volume in each test tube is 4 ml (do not include in your calculation the volume of phenol red that you added to the test tubes).

**Write** the results of your calculations in your answer booklet.

**Provide detailed** calculations for Test Tubes ב and ג only.

- (13 points) 5. א. – Draw a table in which you will summarize the entire experiment setup you conducted in Part ב, as well as its results (Items י–יח).  
– Add a column to the table and record in it the results of your calculation for the concentration of the urea solution (Question 4).  
– In the appropriate place in the table, record the single drop that you added to Test Tube א (Item ט) .  
– Copy into the table the results of the experiment that you recorded in Items יז–יח.

- (3 points) ב. – Give the table a title.  
– Give each column a heading.

- (6 points) 6. א. Suggest an explanation for the results you obtained in Test Tubes ב–ד. Your explanation should also refer to the measurement method.

- (3 points) ב. The treatment in Test Tube א is a control treatment. Explain why the control treatment in Test Tube א is important in this experiment.

- (7 points) 7. א. Based on the results of the test that you conducted in Part א and the result of the experiment in Test Tube ה (in Part ב), answer Sub-Items (1)–(2):

(1) Did boiling the filtrate affect the presence of proteins? Give an explanation based on the results.

(2) Did boiling the filtrate affect the activity of the urease enzyme? Give an explanation based on the results.

- (4 points) ב. Would your answer to Sub-Item א(2) be the same regarding the effect of boiling on the activity of all enzymes in nature? Explain your answer.

- (4 points) 8. א. Below is a list of four of the components of the experiment that you conducted in Part ב. **Copy them into your answer booklet.** For each component write in your **answer booklet** whether it is an independent variable or a constant factor or a method for measuring the dependent variable.

**Components of the experiment:**

- the total volume of the solution in a test tube
- the number of drops of acid required for the phenol red to change color
- the filtrate concentration in Test Tubes א–ד
- the urea concentration in the experimental test tubes

- (3 points) ב. What is the dependent variable in the experiment that you conducted in Part ב?

- (4 points) ג. The temperature of the solution in the test tubes is a constant factor in the experiment that you conducted. Explain why it was important to have this **specific** factor constant in the experiment that you conducted.

יט. Read the passage below and circle the correct option (acidic or basic) in statements I–II.

A student conducted an experiment identical to the one you conducted. He added drops of acid (Item ח) to the solutions in Test Tubes ג–ט until the color of the solutions turned yellow.

I. The yellow color indicates that the environment is acidic/basic.

A few minutes later, the color of the solutions changed back to pink.

II. The pink color indicates that the environment is acidic/basic.

Answer Question 9.

(2 points) 9. א. What is the possible explanation for the color change that happened a few minutes later in the solutions in Test Tubes ג and ט?

Below are four suggested answers. Choose the correct answer and **copy only this answer** into your answer booklet.

- The enzyme was denatured in the acidic environment, and as a result the environment became basic.
- The enzyme continued to be active even in the acidic environment and its activity made the environment basic.
- The enzyme was denatured in the basic environment, and as a result the environment became acidic.
- The enzyme continued to be active even in the basic environment and its activity made the environment acidic.

(2 points) ב. Explain your answer.

**Part 1 – Analyzing research results: The use of urea and a urease enzyme inhibitor in agriculture**

The world's population is expected to continue to grow in the coming years. To provide food for the growing population, agricultural crop yield has to increase.

Agricultural activity sometimes harms the environment and it is important to try to reduce such damage. Urea is an organic compound containing nitrogen atoms (N) that farmers add to the soil to increase crop yield.

Plants absorb nitrogen compounds – such as urea – from the soil. Plant cells use these compounds to build other organic compounds containing nitrogen, such as chlorophyll.

Answer Question **10**.

(2 points) **10. א.** List two additional organic compounds (other than urea and chlorophyll) that are found in plants and contain nitrogen atoms (N).

In a study conducted on different plots in a wheat field, researchers examined the effect of adding urea on crop yield.

In Plot 1, they examined how adding different amounts of urea to the soil affected the weight of a wheat grain crop.

The results of the experiment conducted in Plot 1 are presented in Table 3 below.

**Table 3**

| <b>Amount of urea</b><br>(kg/area unit) | <b>Wheat grain crop</b><br>(ton/area unit) |
|-----------------------------------------|--------------------------------------------|
| 0                                       | 2.5                                        |
| 30                                      | 2.7                                        |
| 60                                      | 3.5                                        |
| 90                                      | 3.8                                        |
| 120                                     | 4.0                                        |

(5 points) **א.** Use the information about chlorophyll given in the introductory passage above to explain the results of the experiment in Plot 1.

**(Note: The exam continues on the next page.)**

The urease enzyme (that you tested in Part ב) is also found in soil, and comes from bacteria and the tissue of dead plants.

The urease enzyme catalyzes the breakdown of urea into ammonia ( $\text{NH}_3$ ). Due to the enzyme's activity, some of the urea added to the soil breaks down. When urea breaks down, ammonia gas is formed, some of which evaporates into the air under certain environmental conditions.

The substance NBPT inhibits the activity of the urease enzyme **in the soil**, and farmers add it to the soil when they add urea. NBPT does not usually damage plants.

In another plot in the wheat field (Plot 2), the researchers examined how adding NBPT to the urea added to the soil affects crop yield.

The results obtained from both plots (Plot 1 with urea only, and Plot 2 with both urea and NBPT) are presented in Table 4 below.

**Table 4**

| Amount of urea<br>(kg/area unit) | Wheat grain crop<br>(ton/area unit) |                    |
|----------------------------------|-------------------------------------|--------------------|
|                                  | Plot 1                              | Plot 2             |
|                                  | Without<br>NBPT                     | With added<br>NBPT |
| 0                                | 2.5                                 | Not tested         |
| 30                               | 2.7                                 | 3.0                |
| 60                               | 3.5                                 | 4.0                |
| 90                               | 3.8                                 | 4.3                |
| 120                              | 4.0                                 | 4.6                |

Answer Question 11.

(10 points) **11. א.** (1) What kind of graphical representation is best suited to describe the results shown in Table 4 – a line graph or a bar diagram? Explain your answer.

(2) Draw a suitable graphical representation of the results in Table 4 in **your answer booklet**.

Note: You do not need to include the value that is labeled "Not tested" in your graphical representation.

(6 points) **ב.** Describe the results of the experiment, based on your graphical representation.

(4 points) **ג.** Use the information given on this page to suggest an explanation for the results of the experiment in Plot 2 (with added NBPT).

**(Note: The exam continues on the next page.)**

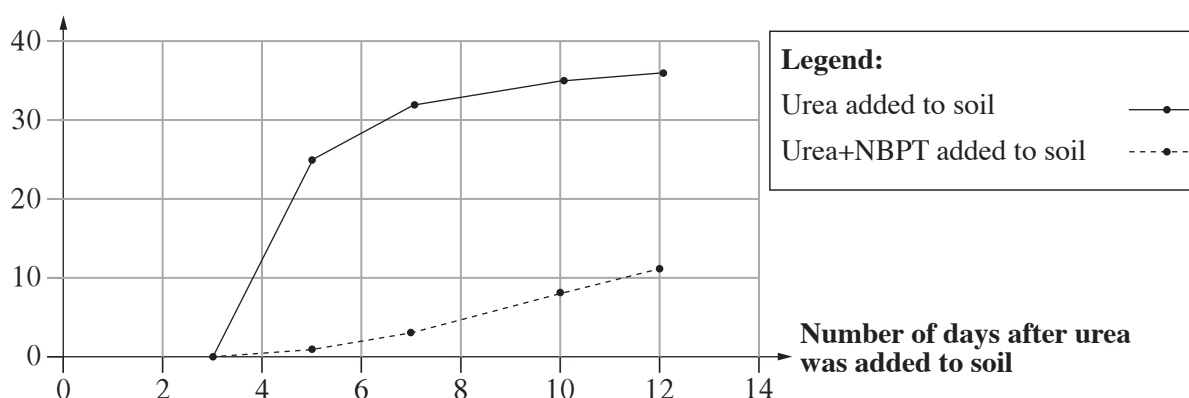
Ammonia gas can be harmful to human health, biodiversity, and various ecosystems. Therefore, many countries seek ways to reduce the amount of ammonia gas that evaporates into the air when urea in the soil breaks down.

In another study, researchers tested the amount of ammonia gas that evaporates into the air in two plots of land: in one plot they added urea, and in another plot they added both urea and NBPT.

The graph below shows the relative quantity of ammonia gas that evaporated into the air over 12 days in both plots.

### Evaporation of ammonia gas from soil to which either only urea or urea+NBPT were added

**Amount of ammonia gas  
evaporating into the air**  
(% of the amount of urea  
added to soil)



Answer Question 12.

- (3 points) **12.** Use the results shown in the graph above to explain how adding NBPT to urea can affect the extent of damage to the environment caused by adding urea to the soil.

**Give the lab teacher your exam paper and your answer booklet.**

**Good Luck!**

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**בהצלחה!**

זכות היוצרים שמורה למדינת ישראל.  
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

## Practical Exam in Biology

## בחינת בגרות מעשית בביולוגיה

### Problem 2

בעיה 2

יש לרשום את מספר תעודת הזהות שלך כאן:

Write your ID number here:

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### Instructions:

### הוראות:

א. משך הבחינה: שלוש שעות.

א. Duration of the exam: Three hours

ב. חומר עזר מותר בשימוש:

ב. Material that may be used during the exam:

- (1) Calculator
- (2) Hebrew–foreign language / foreign language–  
Hebrew dictionary

- (1) מחשבון
- (2) מילון עברי–לועזי / לועזי–עברי

ג. הוראות מיוחדות:

ג. Special instructions:

- (1) Read the instructions carefully and think carefully before each step.
- (2) Write all of your observations and answers in pen (including sketches).
- (3) Base your answers on your observations and the results you obtained, even if they are not as expected.

- (1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב את הצעדים.
- (2) יש לרשום בעט את כל התצפיות והתשובות (גם סרטטים).
- (3) יש לבסס את התשובות על תצפיותיכם ועל התוצאות שקיבלתם, גם אם הן אינן תואמות את הצפוי.

Write in the answer booklet only. Write the word "טיוטה" at the top of each page you use as a draft page. If you write any draft material outside the exam booklet, your exam may be disqualified.

יש לכתוב במחברת הבחינה בלבד. יש לרשום "טייטה" בראש כל עמוד המשמש טיוטה. כתיבת טיוטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

## Problem 2

**In this problem, you will be testing the activity of the urease enzyme in soy seeds.**

The questions in this exam are numbered **13–24**. The point value of each question is listed on the left of each question.

Answer all of the questions in your answer booklet.

### Part א – Testing for the presence of proteins in soy seeds

In this part of the exam, you will be testing for the presence of proteins in soy seeds.

You will conduct the test using two solutions: a basic solution of sodium hydroxide (NaOH), which is colorless and a solution of copper sulfate ( $\text{CuSO}_4$ ), which is light blue. In the presence of a mixture of these two solutions, the color of a liquid that contains proteins will change to purple.

On the table, you have:

- a mortar and pestle; the mortar contains 5 swollen soy seeds
- a test tube containing boiled soy filtrate, labeled "תסנין מורתח"
- a container of distilled water labeled "מים מזוקקים"
- a basic solution of sodium hydroxide (NaOH). Caution! Avoid skin contact with this basic solution.
- a 2% solution of copper sulfate ( $\text{CuSO}_4$ )
- a spoon

Put on the gloves and safety goggles.

#### Step א1: Preparing swollen soy seeds filtrate

- א. Use a glass marking pen to write "תסנין" [filtrate] on an empty test tube.  
Mark a line on the test tube, 10 cm from the bottom of the test tube.
- ב. On the table, you have a funnel and a folded piece of gauze. Line the funnel with the piece of gauze and insert the tip of the funnel into the test tube labeled "תסנין".  
Place the test tube in the test tube rack.
- ג. Use the pestle to slightly crush the seeds in the mortar.
  - Write "מים" on a 10 ml pipette, and use this pipette to add 10 ml of water to the mortar from the container labeled "מים מזוקקים".
  - Crush the seeds for about two minutes.
- ד. Add another 10 ml of water to the mortar and crush for one more minute until you have a pulp.
  - Use the spoon to transfer all the pulp and liquid from the mortar to the gauze in the funnel, and wait until a filtrate is obtained in the test tube.
  - Gather the edges of the gauze and squeeze it to filter the remaining liquid into the test tube. The volume of filtrate should reach the line you marked on the test tube or above it.
  - If the volume of the filtrate does not reach the line you marked on the test tube, squeeze the gauze again.
- ה. Transfer the funnel and the gauze with the remaining seed residue to the mortar.

Step 2: Testing the presence of proteins in soy seeds filtrate and in boiled filtrate

- ו. There are three empty test tubes in the rack. Label them 1, 2, and 3.  
These test tubes will be used to test for the presence of proteins in the solutions: Test Tube 1 to test the filtrate, Test Tube 2 to test the boiled filtrate, and Test Tube 3 to test water.
- ז. Write "תסנין" on a 5 ml pipette.
  - Use it to transfer 1 ml of filtrate from the "תסנין" test tube to Test Tube 1.
- ח. Write "תסנין מורח" on a 5 ml pipette.
  - Use it to transfer 1 ml of boiled filtrate from the "תסנין מורח" test tube to Test Tube 2.
- ט. Use the pipette labeled "מים" to transfer 1 ml of distilled water to Test Tube 3.
  - Add 5 drops of the basic NaOH solution to each of the three experimental test tubes, 1–3.
  - Add 5 drops of the  $\text{CuSO}_4$  solution to each of the three experimental test tubes.
  - Mix the contents of each of the test tubes by shaking them gently, then check the color of the solution in each of the test tubes.

Answer Questions 13-15.

- (6 points) **13.** Copy the table below into your **answer booklet** and fill in the missing information. Determine whether proteins were present in the solutions, based on the information listed in the introduction to Part 2.

**Table 1: Testing for the presence of proteins in the solutions**

| Test Tube | Tested solution | Test result<br>(Color) | Presence of proteins<br>(Yes/No) |
|-----------|-----------------|------------------------|----------------------------------|
| 1         |                 |                        |                                  |
| 2         |                 |                        |                                  |
| 3         |                 |                        |                                  |

- (3 points) **14.** Explain why the test you conducted in Test Tube 3 is important.
- (4 points) **15.** Is it possible to determine the protein concentration in the soy filtrate in Test Tube 1, based on the test you conducted? Explain.

**Place Test Tubes 1–3 in the waste container on your table.**

## Part 2 – Experiment: Testing the activity of the enzyme urease in soy seeds filtrate and the effect of an inhibitor on the enzyme's activity

The compound **urea** is a product of metabolic processes in living cells.

Various organisms (including the soy plant) contain the enzyme **urease**, which catalyzes the breakdown of urea.

One of the products of urea breakdown is ammonia ( $\text{NH}_3$ ) which, in an aqueous environment, combines with water and forms a **basic** substance: **ammonium hydroxide**.

### Step 21: Preparing dilutions of copper sulfate solution

On the table, you have:

- a test tube with urea solution labeled "אוראה"
  - a dropper bottle containing the indicator "פנול אדום" [phenol red]
  - a solution of hydrochloric acid ( $\text{HCl}$ ). Caution! Avoid skin contact with the acid solution.
  - a Pasteur pipette
- י. Ask the lab teacher for a 0.05% solution of copper sulfate labeled "0.05%  $\text{CuSO}_4$  לחלק ב".
- Label 4 empty test tubes: א–ד. Mark them on the upper part of the test tube, close to the rim.
  - Write " $\text{CuSO}_4$ " on a 1 ml pipette and use it to transfer 0.05% solution of  $\text{CuSO}_4$  to Test Tubes ג–ד, according to the information shown in Table 2 below.
- יא. Write "מים" on a 1 ml pipette and use it to transfer water to Test Tubes א–ג, according to the information shown in Table 2.
- Mix the contents of the test tubes by shaking them gently.

**Table 2**

| Test Tube | Volume of<br>0.05% $\text{CuSO}_4$ solution<br>(ml) | Volume of water<br>(ml) |
|-----------|-----------------------------------------------------|-------------------------|
| א         | 0                                                   | 1                       |
| ב         | 0                                                   | 1                       |
| ג         | 0.1                                                 | 0.9                     |
| ד         | 1                                                   | 0                       |

#### Note 1

$\text{CuSO}_4$  solution contains copper ions ( $\text{Cu}^{2+}$ ). Copper ions inhibit the activity of many enzymes, including urease.

In Step 22 you will incubate a filtrate with  $\text{CuSO}_4$  solution, and in Step 23 you will test the activity of the enzyme urease in the filtrate.

### Step 2: Incubating a filtrate with different concentrations of a $\text{CuSO}_4$ solution

On your table you have a container labeled "מי ברז", an empty container labeled "אמבט מים" [water bath] and a thermometer.

- יב. Ask the lab teacher for hot water, and prepare a bath of hot water with a temperature between  $40^\circ\text{--}45^\circ\text{C}$ . If necessary, use tap water from the "מי ברז" container. Make sure that the water level in the bath reaches **at least** up to the line marked on the outside or inside of the bath.
- יג. Use the pipette labeled "תסנין מורתח" to add 3 ml of **boiled** filtrate from the "תסנין מורתח" test tube to Test Tube א.
- יד. **Cap** the "תסנין" test tube **tightly**, and mix the liquid in the test tube by turning the test tube upside-down twice.
  - Use the "תסנין" pipette to add 3 ml of filtrate from the "תסנין" test tube to each of the three test tubes ב–ד.
  - Gently shake each of the test tubes and put them back in the test tube rack.
- טו. Check that the water bath temperature is kept within the range of  $40^\circ\text{C--}45^\circ\text{C}$  and adjust it if necessary.
  - Place the four test tubes א–ד in the bath for 4 minutes. Write down the time \_\_\_\_\_.

While you are waiting, read Items יז–יח (without carrying out any action) and the information in the box labeled Note 2.

- טז. 4 minutes after the time you recorded in Item טו, remove the test tubes from the water bath and put them back in the test tube rack.

### Step 3: Testing the activity of the enzyme urease in the filtrate

- יז. Write "אוראה" on a 1 ml pipette, and use this pipette to add 1 ml of urea to each of the four test tubes א–ד.
  - Gently shake each of the test tubes and put them back in the test tube rack.
  - Write down the time \_\_\_\_\_ and wait 3 minutes.
- יח. 3 minutes after the time you recorded in Item יז, add one drop of phenol red to each of the four test tubes א–ד, and gently shake the test tubes.

#### **Note 2**

In the experiment you are about to conduct, phenol red is an indicator that is red-pink in a basic environment and yellow-orange in an acidic environment.

- יט. Based on the information provided in Note 2, for each of the solutions in Test Tubes א–ד write whether it is acidic or basic:  
Test Tube א \_\_\_\_\_, Test Tube ב \_\_\_\_\_, Test Tube ג \_\_\_\_\_, Test Tube ד \_\_\_\_\_.

During the following steps of the experiment, you will use the solution of hydrochloric acid ( $\text{HCl}$ ) that is on the table. The acid will react with the ammonium base that was formed in the solutions.

#### **Note 3**

The greater the amount of base formed in the solution, the greater the amount of acid required to neutralize the base and change the color of the phenol red indicator.

**Read the instructions in Items כ–כא before you start carrying them out.** You will have to **gradually** add drops of acid to each of the solutions in Test Tubes א–ד, and **count** the drops.

Work carefully and accurately.

- כ. Write "חומצה" on the Pasteur pipette that is on the table.
- Take Test Tube א out of the test tube rack and use the Pasteur pipette to add one drop of HCl acid to this test tube.  
The color of the solution in the test tube will turn light yellow.
  - Put Test Tube א back in the test tube rack.
- כא. Take Test Tube ב out of the test tube rack. Add acid, one drop at a time, to the test tube, shaking the test tube after each drop. **Count the drops** until the solution in Test Tube ב remains a stable light yellow for 10 seconds – **the color should be as close as possible to the color of the solution in Test Tube א**.
- Put the test tube back in the test tube rack.
- Write how many drops you added to Test Tube ב: \_\_\_\_\_ drops.
- Note: After you put the test tube back in the test tube rack, the solution in the test tube may change color. **Ignore** this change.
- כב. Repeat the procedure described in Item כא with Test Tubes ג and ד.
- Write how many drops you added to Test Tube ג: \_\_\_\_\_ drops,  
to Test Tube ד: \_\_\_\_\_ drops.

You do not need gloves and safety goggles for the rest of the exam, so you can take them off now.

Answer Questions 16–20.

- (6 points) **16. Calculate** the concentration of  $\text{CuSO}_4$  solution in each of the test tubes א–ד after you added the filtrate and the urea (in Items י, יד, יז).

Note: The concentration of the  $\text{CuSO}_4$  solution that you used is 0.05%, and the final volume in each test tube is 5 ml (do not include in your calculation the volume of phenol red you added to the test tubes).

**Write** down the results of your calculations in your answer booklet.

**Provide detailed** calculations regarding Test Tubes ג and ד only.

- (13 points) **17.א.** – Draw a table in which you will summarize the entire experiment setup you conducted in Part ב, as well as the results of the experiment (Items י–כב).  
(You may turn the booklet sideways so the table fits the page better.)
- Add a column to the table and record in it your calculation results for the concentration of the copper sulfate solution (Question 16).
  - In the appropriate place in the table, record the single drop that you added to Test Tube א (Item כ).
  - Copy into the table the results of the experiment that you recorded for Items כא–כב.
- (3 points) **ב.** – Give the table a title.
- Give each column a heading.
- (6 points) **18.א.** Explain the results you obtained in Test Tubes ג and ד. Your explanation should refer to the information in Note 1 and to the measurement method.
- (3 points) **ב.** The treatment in Test Tube ב is a control treatment. Explain why the control treatment in Test Tube ב is important in this experiment setup.

- (7 points) **19. א.** Use the results of the test that you conducted in Part א and the result of the experiment in Test Tube א (in Part ב) to answer Sub-Items (1)–(2):
- (1) Did boiling the filtrate affect the presence of proteins? Give an explanation based on the results.
  - (2) Did boiling the filtrate affect the activity of the urease? Give an explanation based on the results.
- (4 points) **ב.** Would your answer to Sub-Item א(2) be the same regarding the effect of boiling on the activity of all enzymes in nature? Explain your answer.
- (4 points) **20. א.** Below is a list of four of the components of the experiment that you conducted in Part ב. **Copy them into your answer booklet.**  
For each component write in your **answer booklet** whether it is an independent variable or a constant factor or the measurement method of the dependent variable.  
**Components of the experiment:**
- the concentration of  $\text{CuSO}_4$  solution in the experimental test tubes
  - the number of drops of phenol red
  - the number of drops of acid required for the phenol red to change color
  - the total volume of the solution in the test tube
- (3 points) **ב.** What is the dependent variable in the experiment that you conducted in Part ב?
- (4 points) **ג.** The initial concentration of urea in the test tubes is a constant factor in the experiment you conducted. Explain why it was important for the initial concentration of urea **specifically** to be a constant factor in the experiment you conducted.

כ. Read the passage below and circle the correct option (acidic or basic) in statements I–II.

A student conducted an experiment identical to the one you conducted. He added drops of acid (Item כב) to the solutions in Test Tubes ב–ג until the color of the solutions turned yellow.

I. The yellow color indicates that the environment is acidic/basic.

A few minutes later, the color of the solutions turned pink again.

II. The pink color indicates that the environment is acidic/basic.

Answer Question 21.

- (2 points) **21. א.** What is the possible explanation for the color change that occurred a few minutes later in the solutions in Test Tubes ב and ג?
- Four possibilities are suggested below. Choose the correct answer and **copy only this explanation** into your answer booklet.
- The enzyme continued to be active even in the acidic environment and its activity made the environment basic.
  - The enzyme was denatured in the acidic environment, and as a result the environment became basic.
  - The enzyme continued to be active even in the basic environment and its activity made the environment acidic.
  - The enzyme was denatured in the basic environment, and as a result the environment became acidic.
- (2 points) **ב.** Explain your answer.

**Part ג – Analyzing research results: The use of urea and a urease enzyme inhibitor in agriculture**

The world's population is expected to continue to grow in the coming years. To provide food for the growing population, agricultural crop yield has to increase.

Agricultural activity sometimes harms the environment and it is important to try to reduce such damage. Urea is an organic compound containing nitrogen atoms (N) that farmers add to the soil to increase crop yield.

Plants absorb nitrogen compounds – such as urea – from the soil. Plant cells use these compounds to build other organic compounds containing nitrogen, such as chlorophyll.

Answer Question **22**.

(2 points) **22. א.** List two additional organic compounds (other than urea and chlorophyll) that are found in plants and contain nitrogen atoms (N).

In a study conducted on different plots in a wheat field, researchers examined the effect of adding urea on crop yield.

In Plot 1, they examined how adding different amounts of urea to the soil affected the weight of a wheat grain crop.

The results of the experiment conducted in Plot 1 are presented in Table 3 below.

**Table 3**

| <b>Amount of urea</b><br>(kg/area unit) | <b>Wheat grain crop</b><br>(ton/area unit) |
|-----------------------------------------|--------------------------------------------|
| 0                                       | 2.5                                        |
| 30                                      | 2.7                                        |
| 60                                      | 3.5                                        |
| 90                                      | 3.8                                        |
| 120                                     | 4.0                                        |

(5 points) **א.** Use the information about chlorophyll given in the introductory passage above to explain the results of the experiment in Plot 1.

**(Note: The exam continues on the next page.)**

The urease enzyme (that you tested in Part ב) is also found in soil, and comes from bacteria and the tissue of dead plants.

The urease enzyme catalyzes the breakdown of urea into ammonia ( $\text{NH}_3$ ). Due to the enzyme's activity, some of the urea added to the soil breaks down. When urea breaks down, ammonia gas is formed, some of which evaporates into the air under certain environmental conditions.

The substance NBPT inhibits the activity of the urease enzyme **in the soil**, and farmers add it to the soil when they add urea. NBPT does not usually damage plants.

In another plot in the wheat field (Plot 2), the researchers examined how adding NBPT to the urea added to the soil affects crop yield.

The results obtained from both plots (Plot 1 with urea only, and Plot 2 with both urea and NBPT) are presented in Table 4 below.

**Table 4**

| Amount of urea<br>(kg/area unit) | Wheat grain crop<br>(ton/area unit) |                    |
|----------------------------------|-------------------------------------|--------------------|
|                                  | Plot 1                              | Plot 2             |
|                                  | Without<br>NBPT                     | With added<br>NBPT |
| 0                                | 2.5                                 | Not tested         |
| 30                               | 2.7                                 | 3.0                |
| 60                               | 3.5                                 | 4.0                |
| 90                               | 3.8                                 | 4.3                |
| 120                              | 4.0                                 | 4.6                |

Answer Question 23.

(10 points) **23. א.** (1) What kind of graphical representation is best suited to describe the results shown in Table 4 – a line graph or a bar diagram? Explain your answer.

(2) Draw a suitable graphical representation of the results in Table 4 in **your answer booklet**.

Note: You do not need to include the value that is labeled "Not tested" in your graphical representation.

(6 points) **ב.** Describe the results of the experiment, based on your graphical representation.

(4 points) **ג.** Use the information given on this page to suggest an explanation for the results of the experiment in Plot 2 (with added NBPT).

**(Note: The exam continues on the next page.)**

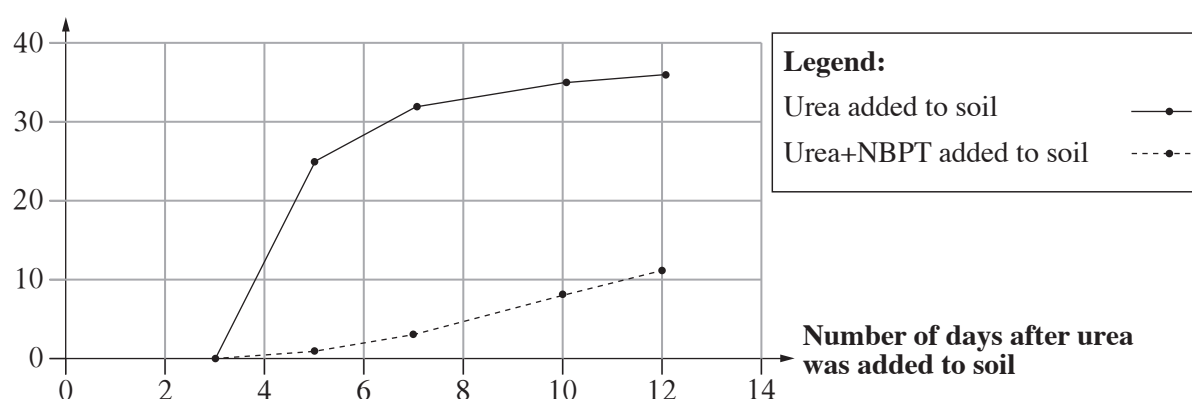
Ammonia gas can be harmful to human health, biodiversity, and various ecosystems. Therefore, many countries seek ways to reduce the amount of ammonia gas that evaporates into the air when urea in the soil breaks down.

In another study, researchers tested the amount of ammonia gas that evaporates into the air in two plots of land: in one plot they added urea, and in another plot they added both urea and NBPT.

The graph below shows the relative quantity of ammonia gas that evaporated into the air over 12 days in both plots.

### Evaporation of ammonia gas from soil to which either only urea or urea+NBPT were added

**Amount of ammonia gas  
evaporating into the air**  
(% of the amount of urea  
added to soil)



Answer question **24**.

- (3 points) **24.** Use the results shown in the graph above to explain how adding NBPT to urea can affect the extent of damage to the environment caused by adding urea to the soil.

**Give the lab teacher your exam paper and your answer booklet.**

**Good Luck!**

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**בהצלחה!**

זכות היוצרים שמורה למדינת ישראל.  
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

## Practical Exam in Biology

## בחינת בגרות מעשית בביולוגיה

### Problem 3

בעיה 3

יש לרשום את מספר תעודת הזהות שלך כאן:

Write your ID number here:

|  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|

### Instructions:

### הוראות:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:

ב. חומר עזר מותר בשימוש:

(1) Calculator

(1) מחשבון

(2) Hebrew–foreign language / foreign language–  
Hebrew dictionary

(2) מילון עברי–לועזי / לועזי–עברי

ג. Special instructions:

ג. הוראות מיוחדות:

(1) Read the instructions carefully and think  
carefully before each step.

(1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב  
את הצעדים.

(2) Write all of your observations and answers in  
pen (including sketches).

(2) יש לרשום בעט את כל התצפיות והתשובות (גם  
סרטטים).

(3) Base your answers on your observations and  
the results you obtained, even if they are not as  
expected.

(3) יש לבסס את התשובות על תצפיותיכם ועל  
התוצאות שקיבלתם, גם אם הן אינן תואמות את  
הצפוי.

Write in the answer booklet only. Write the word  
"טייטה" at the top of each page you use as a draft  
page. If you write any draft material outside the exam  
booklet, your exam may be disqualified.

יש לכתוב במחברת הבחינה בלבד. יש לרשום "טייטה"  
בראש כל עמוד המשמש טייטה. כתיבת טייטה בדפים  
שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

## Problem 3

**In this problem, you will be testing the activity of the urease enzyme in soy seeds.**

The questions in this exam are numbered **25–36**. The point value of each question is listed on the left of each question.

Write all your answers in your answer booklet.

### Part א – Testing for the presence of proteins in soy seeds

In this part of the exam, you will be testing for the presence of proteins in soy seeds.

You will be conduct the test using two solutions: a basic solution of sodium hydroxide (NaOH), which is colorless and a solution of copper sulfate ( $\text{CuSO}_4$ ), which is light blue. In the presence of a mixture of these two solutions, the color of a liquid that contains proteins will change to purple.

On the table, you have:

- a mortar and pestle; the mortar contains 5 swollen soy seeds
- a test tube containing boiled soy filtrate, labeled "תסנין מורתח"
- a container of distilled water labeled "מים מזוקקים"
- a basic solution of sodium hydroxide (NaOH). Caution! Avoid skin contact with this basic solution.
- a 2% solution of copper sulfate ( $\text{CuSO}_4$ )
- a spoon

Put on the gloves and safety goggles.

#### Step א1: Preparing swollen soy seeds filtrate

- Use a glass marking pen to write "תסנין" [filtrate] on an empty test tube.  
Mark a line on the test tube, 10 cm from the bottom of the test tube.
- On the table, you have a funnel and a folded piece of gauze. Line the funnel with the piece of gauze and insert the tip of the funnel into the test tube labeled "תסנין".  
Place the test tube in the test tube rack.
- Use the pestle to slightly crush the seeds in the mortar.
  - Write "מים" on a 10 ml pipette, and use this pipette to add 10 ml of water to the mortar from the container labeled "מים מזוקקים".
  - Crush the seeds for about two minutes.
- Add another 10 ml of water to the mortar and crush for one more minute until you have a pulp.
  - Use the spoon to transfer all the pulp and liquid from the mortar to the gauze in the funnel, and wait until a filtrate is obtained in the test tube.
  - Gather the edges of the gauze and squeeze it to filter the remaining liquid into the test tube. The volume of filtrate should reach the line you marked on the test tube or above it.
  - If the volume of the filtrate does not reach the line you marked on the test tube, squeeze the gauze again.
- Transfer the funnel and the gauze with the remaining seed residue to the mortar.

**Step 2: Testing for the presence of proteins in soy seeds filtrate and in boiled filtrate**

- א. There are three empty test tubes in the rack. Label them 1, 2, and 3.  
 These test tubes will be used to test for the presence of proteins in the solutions: Test Tube 1 to test the filtrate, Test Tube 2 to test the boiled filtrate, and Test Tube 3 to test water.
- ב. Write "תסנין" on a 5 ml pipette.  
 – Use it to transfer 1 ml of filtrate from the "תסנין" test tube to Test Tube 1.
- ג. Write "תסנין מורח" on a 5 ml pipette.  
 – Use it to transfer 1 ml of boiled filtrate from the "תסנין מורח" test tube to Test Tube 2.
- ד. Use the pipette labeled "מים" to transfer 1 ml of distilled water to Test Tube 3.  
 – Add 5 drops of the basic NaOH solution to each of the three experimental test tubes, 1–3.  
 – Add 5 drops of the  $\text{CuSO}_4$  solution to each of the three experimental test tubes.  
 – Mix the contents of each of the test tubes by gently shaking them, and check the color of the solution in each of the test tubes.

Answer questions 25-27.

- (6 points) **25.** Copy the table below into your **answer booklet** and fill in the missing information. Determine whether proteins were present in the solutions, based on the information listed in the introduction to Part A.

**Table 1: Testing the presence of proteins in the solutions**

| Test Tube | Tested solution | Test result<br>(Color) | Presence of proteins<br>(Yes/No) |
|-----------|-----------------|------------------------|----------------------------------|
| 1         |                 |                        |                                  |
| 2         |                 |                        |                                  |
| 3         |                 |                        |                                  |

- (3 points) **26.** Explain why the test you conducted in Test Tube 3 is important.
- (4 points) **27.** Is it possible to determine the protein concentration in the soy filtrate in Test Tube 1, based on the test you conducted? Explain.

**Place Test Tubes 1–3 in the waste container on your table.**

## Part 2 – Experiment: Testing the activity of the urease enzyme in soy seeds filtrate

The compound **urea** is a product of metabolic processes in living cells.

Various organisms (including the soy plant) contain the **urease** enzyme which catalyzes the breakdown of urea.

One of the products of urea breakdown is ammonia ( $\text{NH}_3$ ) which, in an aqueous environment, combines with water and forms a **basic** substance: **ammonium hydroxide**.

### Step 1: Preparing dilutions of soy filtrate

On the table, you have:

- a test tube containing urea solution, labeled "אוראה"
- a dropper bottle containing the indicator "פנול אדום" [phenol red]
- a solution of hydrochloric acid ( $\text{HCl}$ ). Caution! Avoid skin contact with the acid solution.
- a Pasteur pipette

י. Label 5 empty test tubes: א–ה.

- Use the pipette labeled "תסנין מורח" to transfer 3 ml of **boiled** filtrate to Test Tube ה.

יא. **Cap** the "תסנין" test tube **tightly**, and mix the liquid in the test tube by turning the test tube upside-down twice.

- Use the "תסנין" pipette to transfer the filtrate in the "תסנין" test tube to Test Tubes א–ד, according to the information shown in Table 2, below.

יב. Write "מים" on a 5 ml pipette and use it to transfer water to Test Tubes א–ה, according to the information shown in Table 2.

- Mix the contents of the test tubes by shaking them gently.

Table 2

| Test Tube | Volume of soy filtrate (ml) | Volume of water (ml) |
|-----------|-----------------------------|----------------------|
| א         | 3                           | 1                    |
| ב         | 1                           | 2.5                  |
| ג         | 2                           | 1.5                  |
| ד         | 3                           | 0.5                  |
| ה         | 3 (boiled filtrate)         | 0.5                  |

### Step 2: Testing the activity of the urease enzyme in soy seeds filtrate

יג. Write "אוראה" on a 1 ml pipette and use it to add 0.5 ml of urea solution to each of the four Test Tubes ב–ה.

**Do not add urea solution to Test Tube א.**

- Gently shake each of the test tubes and put them back in the test tube rack.
- Write down the time \_\_\_\_\_ and wait 3 minutes.

While you are waiting, read Items טו–יד (without carrying out any action) and the information in the box labeled "Note 1".

- יד. 3 minutes after the time you recorded in Item יג, add one drop of phenol red to each of the five test tubes ט–ה, and gently shake the test tubes.

**Note 1**

In the experiment you are about to conduct, phenol red is an indicator that is red-pink in a basic environment and yellow-orange in an acidic environment.

- טו. Based on the information provided in Note 1, write for each of the solutions in Test Tubes ט–ה whether it is acidic or basic:

Test Tube ט \_\_\_\_\_, Test Tube טו \_\_\_\_\_, Test Tube ג \_\_\_\_\_, Test Tube ד \_\_\_\_\_, Test Tube ה \_\_\_\_\_.

During the following steps of the experiment, you will use the solution of hydrochloric acid ( $\text{HCl}$ ) that is on the table. The acid will react with the ammonium base that was formed in the solutions.

**Note 2**

The greater the amount of base formed in the solution, the greater the amount of acid required to neutralize the base and change the color of the phenol red indicator.

**Read the instructions in Items יז–יט before you start carrying them out.** You will have to **gradually** add drops of acid to each of the solutions in Test Tubes ט–ה, and **count** the drops.

Work carefully and accurately.

- יט. Write "חומצה" on the Pasteur pipette that is on the table.
- Take Test Tube ט out of the test tube rack and use the Pasteur pipette to add one drop of the acid  $\text{HCl}$ . The color of the solution in the test tube will turn light yellow.
  - Put Test Tube ט back in the test tube rack.
- יז. Take Test Tube טו out of the test tube rack. Add acid drop by drop to the test tube and shake the test tube after adding each drop. **Count the drops** until the solution in Test Tube טו remains a stable light yellow for 10 seconds – **the color should be as close as possible to the color of the solution in Test Tube ט**. Put the test tube back in the test tube rack.
- Write how many drops you added into Test Tube טו: \_\_\_\_\_ drops.

Note: After you put the test tube back in the test tube rack, the solution in the test tube may change color. **Ignore** this change.

- יח. Repeat the procedure described in Item יז with test tubes ג, ד, ה.
- Write how many drops you added to Test Tube ג: \_\_\_\_\_ drops,  
to Test Tube ד: \_\_\_\_\_ drops,  
to Test Tube ה: \_\_\_\_\_ drops.

You do not need gloves and safety goggles for the rest of the exam, so you can take them off now.

Answer Questions 28–32.

- (6 points) 28. **Calculate** the concentration of the filtrate in Test Tube א (Table 2). **Record** the results of your calculations in your answer booklet.
- **Calculate** the filtrate concentration in each of Test Tubes ה–ב after you added urea solution (in Item יג).
- Note: The concentration of the filtrate that you used is 100 % , and the final volume in each test tube is 4 ml (do not include in your calculation the volume of phenol red that you added to the test tubes).
- Write** the results of your calculations in your answer booklet.
- **Provide detailed** calculations for Test Tubes ב and ג only.
- (13 points) 29. א. – Draw a table in which you will summarize the entire experiment setup you conducted in Part ב, as well as its results (Items יח–י).
- Add a column to the table and record in it the results of your calculation for the concentration of the filtrate (Question 28).
  - In the appropriate place in the table, record the single drop that you added to Test Tube א (Item יט) .
  - Copy into the table the results of the experiment that you recorded in Items יח–י.
- (3 points) ב. – Give the table a title.
- Give each column a heading.
- (6 points) 30. א. Suggest an explanation for the results you obtained in Test Tubes ב–ה. Your explanation should also refer to the measurement method.
- (3 points) ב. The treatment in Test Tube א is a control treatment. Explain why the control treatment in Test Tube א is important in this experiment.
- (7 points) 31. א. Based on the results of the test that you conducted in Part א and the result of the experiment in Test Tube ה (in Part ב), answer Sub-Items (1)–(2):
- (1) Did boiling the filtrate affect the presence of proteins? Give an explanation based on the results.
  - (2) Did boiling the filtrate affect the activity of the urease enzyme? Give an explanation based on the results.
- (4 points) ב. Would your answer to Sub-Item א(2) be the same regarding the effect of boiling on the activity of all enzymes in nature? Explain your answer.

(4 points) 32. א. Below is a list of four of the components of the experiment that you conducted in Part ב. **Copy them into your answer booklet.**

For each component write in your **answer booklet** whether it is an independent variable or a constant factor or a method for measuring the dependent variable.

**Components of the experiment:**

- the number of drops of phenol red
- the filtrate concentration in Test Tubes א–ד
- the total volume of the solution in a test tube
- the number of drops of acid required for of the phenol red to change the color.

(3 points) ב. What is the dependent variable in the experiment that you conducted in Part ב?

(4 points) ג. The initial concentration of urea solution in Test Tubes ב–ה is a constant factor in the experiment that you conducted. Explain why it was important to have this **specific** factor constant in the experiment that you conducted.

ו. Read the passage below and circle the correct option (acidic or basic) in statements I–II.

A student conducted an experiment identical to the one you conducted. He added drops of acid (Item ו) to the solutions in Test Tubes ג–ה until the color of the solutions turned yellow.

I. The yellow color indicates that the environment is acidic/basic.

A few minutes later, the color of the solutions changed back to pink.

II. The pink color indicates that the environment is acidic/basic.

Answer Question 33.

(2 points) 33. א. What is the possible explanation for the color change that happened a few minutes later, in the solutions in Test Tubes ג and ה?

Below are four suggested answers. Choose the correct answer and **copy only this answer** into your answer booklet.

- The enzyme was denatured in the basic environment, and as a result the environment became acidic.
- The enzyme was denatured in the acidic environment, and as a result the environment became basic.
- The enzyme continued to be active even in the basic environment and its activity made the environment acidic.
- The enzyme continued to be active even in the acidic environment and its activity made the environment basic.

(2 points) ב. Explain your answer.

**Part ג – Analyzing research results: The use of urea and a urease enzyme inhibitor in agriculture**

The world's population is expected to continue to grow in the coming years. To provide food for the growing population, agricultural crop yield has to increase. Agricultural activity sometimes harms the environment and it is important to try to reduce such damage.

Urea is an organic compound containing nitrogen atoms (N) that farmers add to the soil to increase crop yield.

Plants absorb nitrogen compounds – such as urea – from the soil. Plant cells use these compounds to build other organic compounds containing nitrogen, such as chlorophyll.

Answer Question **34**.

(2 points) **34. א.** List two additional organic compounds (other than urea and chlorophyll) that are found in plants and contain nitrogen atoms (N).

In a study conducted on different plots in a wheat field, researchers examined the effect of adding urea on crop yield.

In Plot 1, they examined how adding different amounts of urea to the soil affected the weight of a wheat grain crop.

The results of the experiment conducted in Plot 1 are presented in Table 3 below.

**Table 3**

| <b>Amount of urea</b><br>(kg/area unit) | <b>Wheat grain crop</b><br>(ton/area unit) |
|-----------------------------------------|--------------------------------------------|
| 0                                       | 2.5                                        |
| 30                                      | 2.7                                        |
| 60                                      | 3.5                                        |
| 90                                      | 3.8                                        |
| 120                                     | 4.0                                        |

(5 points) **א.** Use the information about chlorophyll given in the introductory passage above to explain the results of the experiment in Plot 1.

**(Note: The exam continues on the next page.)**

The urease enzyme (that you tested in Part ב) is also found in soil, and comes from bacteria and the tissue of dead plants.

The urease enzyme catalyzes the breakdown of urea into ammonia ( $\text{NH}_3$ ). Due to the enzymes' activity, some of the urea added to the soil breaks down. When urea breaks down, ammonia gas is formed, some of which evaporates into the air under certain environmental conditions.

The substance NBPT inhibits the activity of the urease enzyme **in the soil**, and farmers add it to the soil when they add urea. NBPT does not usually damage plants.

In another plot in the wheat field (Plot 2), researchers examined how adding NBPT to the urea added to the soil affects crop yield.

The results obtained from both plots (Plot 1 with urea only, and Plot 2 with both urea and NBPT) are presented in Table 4 below.

**Table 4**

|                                         | <b>Wheat grain crop</b><br>(ton/area unit) |                        |
|-----------------------------------------|--------------------------------------------|------------------------|
|                                         | Plot 1                                     | Plot 2                 |
|                                         | <b>Without NBPT</b>                        | <b>With added NBPT</b> |
| <b>Amount of urea</b><br>(kg/area unit) |                                            |                        |
| 0                                       | 2.5                                        | Not tested             |
| 30                                      | 2.7                                        | 3.0                    |
| 60                                      | 3.5                                        | 4.0                    |
| 90                                      | 3.8                                        | 4.3                    |
| 120                                     | 4.0                                        | 4.6                    |

Answer Question 35.

(10 points) **35. א.** (1) What kind of graphical representation is best suited to describe the results shown in Table 4 – a line graph or a bar diagram? Explain your answer.

(2) Draw a suitable graphical representation of the results in Table 4 in **your answer booklet**.

Note: You do not need to include the value that is labeled "Not tested" in your graphical representation.

(6 points) **ב.** Describe the results of the experiment, based on your graphical representation.

(4 points) **ג.** Use the information given on this page to suggest an explanation for the results of the experiment in Plot 2 (with added NBPT).

**(Note: The exam continues on the next page.)**

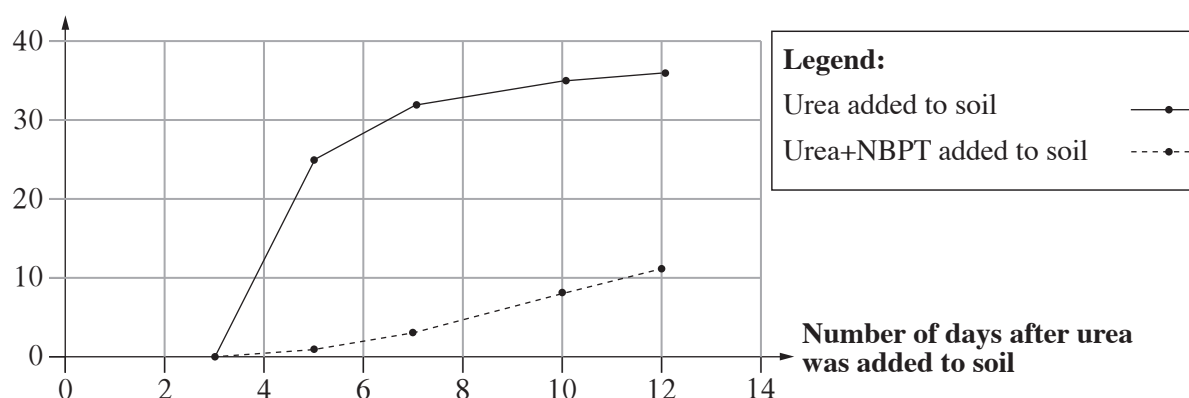
Ammonia gas can be harmful to human health, biodiversity, and various ecosystems. Therefore, many countries seek ways to reduce the amount of ammonia gas that evaporates into the air when urea in the soil breaks down.

In another study, researchers tested the amount of ammonia gas that evaporates into the air in two plots of land: In one plot they added urea, and in another plot they added both urea and NBPT.

The graph below shows the relative quantity of ammonia gas that evaporated into the air over 12 days in both plots.

### Evaporation of ammonia gas from soil to which either only urea or urea+NBPT were added

**Amount of ammonia gas  
evaporating into the air**  
(% of the amount of urea  
added to soil)



Answer Question 36.

- (3 points) **36.** Use the results shown in the graph above to explain how adding NBPT to urea can affect the extent of damage to the environment that may be caused by adding urea to the soil.

**Give the lab teacher your exam paper and your answer booklet.**

**Good Luck!**

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**בהצלחה!**

זכות היוצרים שמורה למדינת ישראל.  
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

## Practical Exam in Biology

## בחינת בגרות מעשית בביולוגיה

### Problem 4

### בעיה 4

יש לרשום את מספר תעודת הזהות כאן:  
Write your ID number here:

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#### Instructions:

#### הוראות:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:

ב. חומר עזר מותר בשימוש:

- (1) Calculator
- (2) Hebrew– foreign language / foreign language–Hebrew dictionary

- (1) מחשבון.
- (2) מילון עברי– לועזי / לועזי– עברי.

ג. Special instructions:

ג. הוראות מיוחדות:

- (1) Read the instructions carefully and think carefully before each step.
- (2) Write all of your observations and answers in pen (including sketches).
- (3) Base your answers on your observations and the results that you obtained, even if they are not as expected.

- (1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב את צעדיכם.
- (2) יש לרשום בעט את כל התצפיות והתשובות (גם סרטטים).
- (3) יש לבסס את התשובות על תצפיותיכם ועל התוצאות שקיבלתם וגם אם הן אינן תואמות את הצפוי.

Write in the answer booklet only. Write the word "טייטה" at the top of each page you use as a draft page. If you write any draft material outside the exam booklet, your exam may be disqualified.

יש לכתוב במחברת הבחינה בלבד. יש לרשום "טייטה" בראש כל עמוד המשמש טייטה. כתיבת טייטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

**Good Luck!**

**בהצלחה!**

## Problem 4

**In this problem, you will examine factors that affect the process of cellular respiration in yeast.**

The questions in this exam are numbered **37–48**. The point value of each question is listed to its left.

Write all of your answers in the answer booklet.

### Part א – Learning the method of measurement

#### Step א1: Learning the properties of phenolphthalein indicator

- On the table, you have:
- a container of distilled water
  - a dropper bottle containing a solution of phenolphthalein
  - a test tube containing a basic solution of sodium hydroxide (NaOH).  
Caution! Avoid skin contact with the basic solution.
  - a Pasteur pipette labeled "NaOH"
  - a solution of hydrochloric acid (HCl). Caution! Avoid skin contact with acid solution

Put on the gloves and safety goggles.

- Use a glass marking pen to label three test tubes: א, ב, ג.
  - Write "מים" on a 10 ml pipette.
  - Use the pipette to transfer 3 ml of distilled water to each of the test tubes א, ב, ג.
  - Add 2 drops of phenolphthalein solution to each of the three test tubes. Gently shake the test tubes.
- Use the "NaOH" Pasteur pipette to add 3 drops of the base NaOH to Test Tube א and gently shake the test tube.
- Add one drop of HCl acid to Test Tube ב and gently shake the test tube.
  - Add 3 drops of HCl acid to Test Tube ג and gently shake the test tube.

Answer Question 37.

- (5 points) **37.א.** Copy Table 1 below into your **answer booklet**.

Observe the solutions you obtained in the test tubes after adding drops of base or acid. Determine the color of the solution in each of the test tubes and write the color (pink or colorless) in the appropriate place in the table in your answer booklet (under Step I in the table).

**Table 1**

| Step I    |                                          |                                         |                                                     | Step II                                                                  |
|-----------|------------------------------------------|-----------------------------------------|-----------------------------------------------------|--------------------------------------------------------------------------|
| Test Tube | Volume of NaOH base<br>(number of drops) | Volume of HCl acid<br>(number of drops) | Color of the resulting solution<br>(pink/colorless) | Results: number of drops of NaOH base added until pink color is obtained |
| א         | 3                                        | –                                       |                                                     |                                                                          |
| ב         | –                                        | 1                                       |                                                     |                                                                          |
| ג         | –                                        | 3                                       |                                                     |                                                                          |

- (2 points) **א.** Copy the two sentences below into **your answer booklet** and fill in the missing part in each sentence.

The color of phenolphthalein indicator in a basic environment is \_\_\_\_\_.

The color of phenolphthalein indicator in an acidic environment is \_\_\_\_\_.

Step 2: Learning a method for measuring the amount of acid in a solution (titration)

In the next part of the experiment, you will **gradually** add drops of a base to each of the solutions in Test Tubes ב-ג, and you will **count** the drops.

**Read the instructions in Items 7-8 before you start carrying them out.**

Work carefully and accurately.

7. Take Test Tube ב out of the test tube rack and use the "NaOH" Pasteur pipette to add the basic NaOH solution drop by drop to the test tube. Shake the test tube after you add each drop. **Count the drops** until the solution remains a stable pink for 10 seconds in Test Tube ב – **the color should be as close as possible to the color of the solution that is in Test Tube א.**
  - Put the test tube back in the test tube rack.
  - Write the number of drops that you added to Test Tube ב in the appropriate place in Table 1 (under Step II in the table) **in your answer booklet.**
8. Take Test Tube ג out of the test tube rack and repeat the procedure described in Item 7 with this test tube.

Answer Question 38.

- (4 points)      **38.** Explain why each of the test tubes ב-ג requires a **different** number of drops to obtain a color similar to the color of the solution in Test Tube א.

**Put Test Tubes א-ג in the waste container.**

## Part 2 – Experiment: The effect of ethanol and magnesium chloride ( $\text{MgCl}_2$ ) on the rate of cellular respiration in yeast

### Note 1

- א. Ethanol is a substance that dissolves fats and modifies the spatial structure of proteins.
- ב. In a solution of magnesium chloride ( $\text{MgCl}_2$ ), there are magnesium ions ( $\text{Mg}^{2+}$ ). The magnesium ions bind to many enzymes in the cell and make them more efficient. Magnesium ions also improve the stability of cell membranes.

On the table, you have:

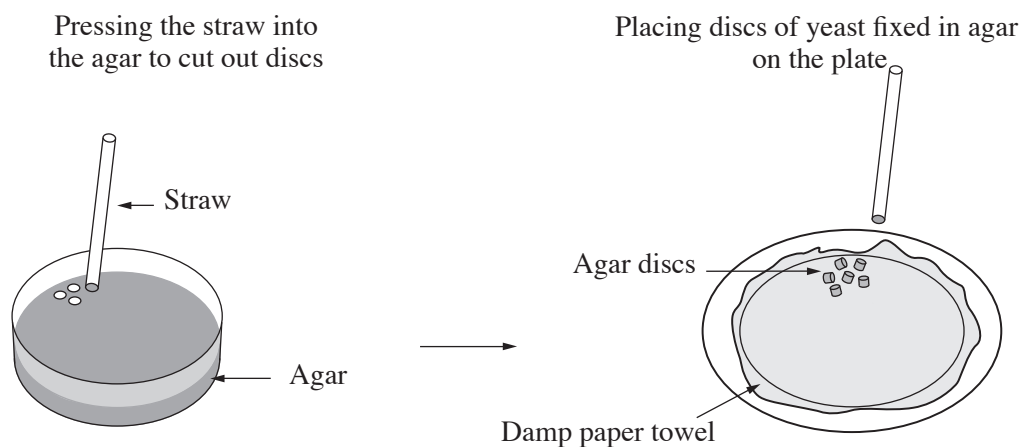
- a Petri dish with yeast fixed in agar
- a short straw
- a plate lined with a damp paper towel
- a test tube containing 70 % ethanol solution
- a test tube containing  $\text{MgCl}_2$  solution
- a container with glucose solution

### Step 1: Preparing discs of yeast fixed in agar

You will be preparing discs from the agar in the dish, using a straw, according to the instructions in Item 1 below.

**Read the instructions to the end and only then carry them out.**

**Figure 1: Preparing discs of yeast fixed in agar**



**Figure 1a:**  
Preparing discs from the agar

**Figure 1b:**  
Placing discs on the plate

1. Hold the straw and press it into the agar until it reaches the bottom of the dish (see figure 1a). Give the straw a half turn, tilt it slightly, and pull it out of the agar. Note: There is a disc of agar inside the straw now.
  - Repeat this procedure two more times so that you have 3 discs inside the straw.
  - Now remove the discs from the straw and place them on the lined plate, as follows: Hold the straw in the middle and squeeze it with your fingers. Continue squeezing a few more times, every time moving your fingers a little further down towards the bottom of the straw. By squeezing the straw, you will push the agar discs down the straw until they are released onto the plate.
  - Repeat the above procedure until you have 40 discs on the plate.

/continued on page 5/

**Note 2**

Agar is a substance with a jello-like texture that is not harmful to yeast cells. When discs of yeast fixed in agar are soaked in a solution, the agar allows the passage of substances from the external solution into the yeast cells and from the yeast to the solution.

- ז. Label four test tubes: 1, 2, 3, 4. Mark them on the upper part of each test tube, close to the test tube rim.
- ח. Take two 10 ml pipettes and write " $\text{MgCl}_2$ " on one, and "אתנול" on the other.
- ט. Based on the information in Table 2 below:
  - Add distilled water to Test Tubes 1–4 using the "מים" pipette (from Part א).
  - Add  $\text{MgCl}_2$  solution and then ethanol solution to the test tubes using the appropriate pipettes.

**Table 2**

| Test Tube | Volume of distilled water (ml) | Volume of $\text{MgCl}_2$ solution (ml) | Volume of 70% ethanol solution (ml) |
|-----------|--------------------------------|-----------------------------------------|-------------------------------------|
| 1         | 8                              | 0                                       | 0                                   |
| 2         | 7                              | 0                                       | 1                                   |
| 3         | 4                              | 0                                       | 4                                   |
| 4         | 0                              | 4                                       | 4                                   |

- י. On the table, you have a container labeled "אמבט מים", a container with tap water, a thermometer, and caps for the test tubes.
  - Ask the lab teacher for hot water and prepare a water bath with a temperature between  $38^\circ\text{C}$ – $42^\circ\text{C}$ .
  - Use tap water from the container labeled "מי ברז" if necessary. Check that the water level in the water bath reaches the line marked on the outside or inside of the water bath. If the water level in the water bath is above the marked line, pour the excess water into the waste container.
- יא. Use a spoon to carefully place 8 discs of yeast fixed in agar in each of Test Tubes 1–4. Be careful not to squash the discs. Do not add broken discs (that were damaged during the preparation process) to the test tubes.
- יב. **Cap** the test tubes and put them into the water bath.
  - Write the time \_\_\_\_\_, and wait 6 minutes.
  - While you are waiting, check that the water bath temperature is kept within the range, adjusting it if necessary, and answer Question 39.

Answer Question 39.

(6 points) **39. Calculate** the concentration of ethanol in each of the solutions in Test Tubes 1–4.

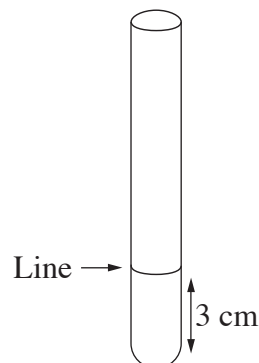
Note: The concentration of ethanol in the solution you used is 70 %, and the final volume in each test tube is 8 ml.

**Record** the results of your calculations in the answer booklet.

- **Provide detailed** calculations for Test Tubes 2 and 3 only.

- יג. 6 minutes after the time you recorded in Item יב, take the test tubes out of the water bath, shake them gently and put them in the test tube rack.
- Label a 10 ml pipette "גְּלוֹקוֹז".
  - Use the "גְּלוֹקוֹז" pipette to add 4 ml of glucose solution to each of Test Tubes 1–4.
  - **Cap** all the test tubes again and shake them gently to mix the solutions.
  - Check that the numbers you marked on the test tubes **have not been erased** and correct them if necessary.
- יד. Check that the water bath temperature is kept within the range of 38°C–42°C and adjust it if necessary.
- Put Test Tubes 1–4 into the water bath.
  - Write down the time: \_\_\_\_\_, and wait 10 minutes.
  - While you are waiting, follow the instructions in Item טו below and read Item טז (without carrying out any action).
- Check that the bath temperature is kept within the range.
- טו. Label four empty test tubes: A, B, C, D.
- Use a ruler to mark a line on each of Test Tubes A–D, at a height of 3 cm from the bottom of the test tube (see Figure 2).

**Figure 2 : Marking Test Tubes A–D**



- Put Test Tubes A–D in the test tube rack in the row closest to you.
  - On the table, you have four new Pasteur pipettes; label them 1A, 2B, 3C, 4D.
- טז. 10 minutes after the time you recorded in Item יד, take Test Tubes 1–4 out of the water bath and arrange them in the test tube rack in the following order:
- Place Test Tube 1 behind Test Tube A, Test Tube 2 behind Test Tube B, and Test Tubes 3 and 4 behind Test Tube C and D, respectively.
- יז. Use Pasteur pipette 1A to transfer the solution from Test Tube 1 to Test Tube A, up to the line marked on the test tube.
- Repeat this procedure with Pasteur pipette 2B to transfer the solution from Test Tube 2 to Test Tube B.
  - Repeat this procedure with the appropriate Pasteur pipettes and with Test Tubes 3 and C, and 4 and D, respectively.

Step 2: Testing the relative amount of acid in each of Test Tubes A–D

**Note 3**

The reaction between carbon dioxide ( $\text{CO}_2$ ) and water forms an acid (carbonic acid).

ח. Add 2 drops of phenolphthalein to each of Test Tubes A–D.

**Read the instructions in Item ט before you carry them out.**

ט. Take Test Tube A out the test tube rack.

- Use the "NaOH" Pasteur pipette to add basic NaOH solution drop by drop to Test Tube A, shaking the test tube after you add each drop. **Count the drops** until the solution remains a stable pink for 10 seconds.

**Note:** The intensity of the pink color you obtained here may be weak compared to the one you obtained in Part א of the experiment.

- Write the number of drops of NaOH base you added to Test Tube A: \_\_\_\_\_ drops.

**Note:** After you put the test tube back in the test tube rack, the color of the solution in the test tube may change; ignore this change.

ז. Repeat the procedure you carried out in Item ט with Test Tubes B, C and D, and count the drops you add until the solution remains a stable pink – **the color should be as close as possible to the color of the solution obtained in Test Tube A.**

Write the number of drops that you added

|                 |              |
|-----------------|--------------|
| in Test Tube B: | _____ drops; |
| in Test Tube C: | _____ drops; |
| in Test Tube D: | _____ drops. |

You do not need gloves and safety goggles for the rest of the exam, so you can take them off now.

Answer Questions 40–45.

(7 points) 40. א. Below are four of the components of the experiment you conducted in Part ז.

**Copy them into your answer booklet.**

For each component, write in your **answer booklet** whether it is a constant factor or a dependent variable or a method of measurement of the dependent variable.

**Components of the experiment:**

- cellular respiration rate in yeast fixed in agar
- number of drops of NaOH base required to change the color of the solution to pink
- initial concentration of glucose in the test tubes
- temperature of water in the water bath

(3 points) ב. The presence of magnesium chloride ( $\text{MgCl}_2$ ) in the test tubes is an independent variable in the experiment you conducted.

What is the other independent variable in the experiment?

(13 points)      **41.    8.**      In your **answer booklet**, draw a table summarizing the experiment setup and the results. You may turn the booklet sideways so the table fits the page better.

Your table should include only the following components:

- ethanol concentration (Question 39)
- volume of  $\text{MgCl}_2$  solution
- presence of discs of yeast (Item 8)
- presence of glucose (Item 9)
- experiment results in Test Tubes A–D (Items 10–13)

(4 points)      **a.**

- Give the table a title.
- Give a heading to each column in the table.

(4 points)      **42.**      You added 8 discs of yeast fixed in agar to each of the solutions in the experiment. Explain why it was important that the number of discs **specifically** was a constant factor in the experiment.

(6 points)      **43.    ⌘.**      Suggest an explanation for the results of the experiment you obtained in each of the test tubes A–C. In your answer refer to the information given in Notes 1 and 3 and also to the measurement method.

(4 points)      **2.**      Suggest an explanation for the difference between the result you obtained in Test Tube C and the result you obtained in Test Tube D. In your answer refer also to the information given in Notes 1 and 3.

(4 points)      a.      A student suggested adding another treatment to the experiment setup – a test tube containing 12 ml of water and 8 discs of yeast **only** (with no added glucose solution).

Hypothesize whether the number of drops of base required to obtain a pink color in the solution taken from this test tube would be smaller than, equal to, or greater than the number of drops you added to Test Tube A (Item 5). Explain your hypothesis.

(3 points) **44.** The procedure you conducted in Test Tube 1 is a control treatment. Why was it important to include the control treatment in Test Tube 1 in the experiment setup?

(4 points) **45.** Students who carried out the same experiment you conducted (in Part 3) argued that the effect of ethanol on cellular respiration rate would be similar in all living organisms. Is the students' argument correct? Explain your answer.

### Part ג – Analyzing the results of an experiment: the effect of ethanol concentration on yeast reproduction

Ethanol is one of the products of the fermentation process that occurs in yeast. Ethanol is very important in the wine industry, and is also used as biofuel, disinfectant, and more.

Ethanol at certain concentrations in the yeast's environment limits the rate of processes in the yeast cells, and their reproduction rate also slows down.

Many researchers are looking for a strain of yeast that can survive in an environment with a high ethanol concentration and reproduce rapidly.

#### Experiment 1

Researchers added various concentrations of ethanol to a liquid culture medium containing yeast.

They tested the reproduction rate of two yeast strains over the course of 48 hours.

Table 3 below shows data on the reproduction rate of yeast in solutions containing different concentrations of ethanol.

| Concentration of ethanol (%) | Reproduction rate of yeast<br>(relative units) |          |
|------------------------------|------------------------------------------------|----------|
|                              | Strain A                                       | Strain B |
| 0                            | 1.9                                            | 2.0      |
| 4                            | 1.9                                            | 2.1      |
| 8                            | 1.3                                            | 1.8      |
| 10                           | 0.7                                            | 1.6      |
| 12                           | 0.2                                            | 1.3      |
| 16                           | 0.0                                            | 0.5      |

Answer Question 46.

(10 points) **46. א.** (1) What type of graphical representation is best suited to describe the results shown in Table 3 – a line graph or a bar diagram? Explain your answer.

(2) Draw a suitable graphical representation of the results in Table 3 in **your answer booklet**.

(6 points) **ב.** Describe the results of Experiment 1, based on your graphical representation.

(3 points) **ג.** **Determine** which of the two strains – Strain A or Strain B – is more resistant to the effects of ethanol. **Explain** your answer. Base your answer on the results shown in the graph you drew.

(Note: The exam continues on the next page.)

/continued on page 10/

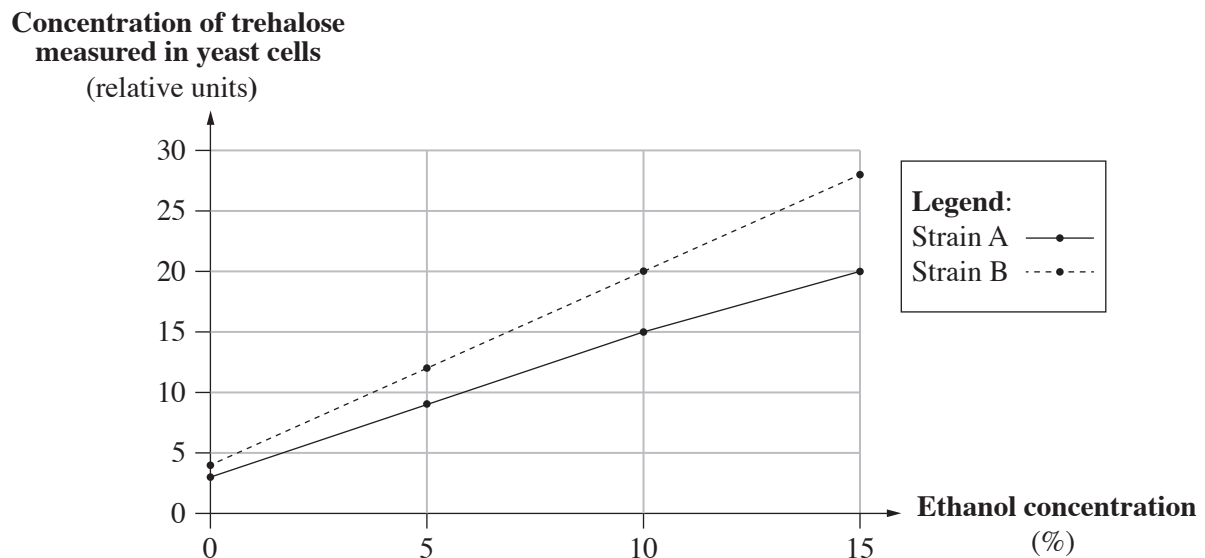
## Experiment 2

Yeast cells contain a sugar –trehalose– which serves as a storage compound. Studies found that the presence of trehalose in yeast cells protects them from the damage caused by ethanol to cell membranes and proteins.

Researchers grew yeast of both strains in solutions containing ethanol at different concentrations. After a while, they measured the concentrations of trehalose in the yeast cells.

The results are shown in Graph 2.

**Graph 2: Effect of concentration of ethanol in a solution on the concentration of trehalose in yeast cells**



Answer Questions 47-48.

(5 points) **47.** Based on the results shown in Graph 2 and the information about the sugar trehalose, explain the results for Strain B shown in the graph you drew (in Question 46).

Yeasts cells contain an enzyme that catalyzes the synthesis of the sugar trehalose from monosaccharides, and another enzyme that catalyzes the breakdown of trehalose into monosaccharides. These enzymes are active in the cell depending on the concentrations of ethanol in and around the cell.

In both yeast strains, the researchers tested the activity of the enzyme that catalyzes the breakdown of the cell's trehalose into monosaccharides.

They found that in a 10 % ethanol solution, the activity rate of the enzyme that catalyzes the breakdown of trehalose was lower in Strain B than in Strain A, but the reproduction rate was higher in Strain B than in Strain A.

(4 points) **48. א.** Explain why in a 10% ethanol solution, the low activity rate of the enzyme that catalyzes the breakdown of trehalose allows a higher reproduction rate in Strain B compared with Strain A.

(3 points) **ב.** Explain how protecting the cell membrane in an environment containing ethanol allows yeast cells to maintain homeostasis.

**Give the lab teacher your exam paper and your answer booklet.**

**Good Luck!**

**בהצלחה!**

## Practical Exam in Biology

## בחינת בגרות מעשית בביולוגיה

### Problem 5

### בעיה 5

יש לרשום את מספר תעודת הזהות שלך כאן:  
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#### Instructions for examinees:

#### הוראות לנבחן:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:

ב. חומר עזר מותר בשימוש

(1) Calculator

(1) מחשבון.

(2) Hebrew–foreign language / foreign language–Hebrew dictionary

(2) מילון עברי–לועזי / לועזי–עברי.

ג. Special instructions:

ג. הוראות מיוחדות:

(1) Read the instructions carefully and think carefully before each step.

(1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב את צעדיכם.

(2) Write all of your observations and answers in pen (including sketches).

(2) יש לרשום בעט את כל התצפיות והתשובות (גם סרטטים).

(3) Base your answers on your observations and the results that you obtained, even if they are not as expected.

(3) יש לבסס את התשובות על תצפיותיכם ועל התוצאות שקיבלתם גם אם

הן אינן תואמות את הצפוי.

Write in the exam booklet only. Write the word "טיוטה" at the top of each page you use as a draft page. If you write any draft material outside the exam booklet, your exam may be disqualified.

יש לכתוב במחברת הבחינה בלבד. יש לרשום "טיוטה" בראש כל עמוד המשמש טיוטה. כתיבת טיוטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

**Good Luck!**

**בהצלחה!**

## Problem 5

**In this problem, you will examine factors that affect the process of cellular respiration in yeast.**

The questions in this exam are numbered **49–60**. The point value of each question is given on the left.

Write all of your answers in the answer booklet.

### Part א — Learning a method of measurement

#### Step א1: Learning the properties of phenolphthalein indicator

- On the table, you have:
- a container of distilled water
  - a dropper bottle containing a solution of phenolphthalein
  - a test tube containing a basic solution of sodium hydroxide (NaOH)  
Caution! Avoid skin contact with the basic solution.
  - a Pasteur pipette labeled "NaOH"
  - a solution of hydrochloric acid (HCl). Caution! Avoid skin contact with the acid solution.

Put on the gloves and safety goggles.

- Use a glass marking pen to label three test tubes: א, ב, ג.
  - Write "מים" on a 10 ml pipette.
  - Use the pipette to transfer 3 ml of distilled water to each of the test tubes א, ב, ג.
  - Add 2 drops of phenolphthalein solution to each of the three test tubes. Gently shake the test tubes.
- Use the "NaOH" Pasteur pipette to add 3 drops of the base NaOH to Test Tube א and gently shake the test tube.
- Add one drop of HCl acid to Test Tube ב and gently shake the test tube.
  - Add 3 drops of HCl acid to Test Tube ג and gently shake the test tube.

Answer Question **49**.

(5 points) **49. א.** Copy Table 1 below into your **answer booklet**.

Observe the solutions you obtained in the test tubes after adding drops of base or acid. Determine the color of the solution in each of the test tubes and write the color (pink or colorless) in the appropriate place in the table in your answer booklet (in Step I in the table).

**Table 1**

| Step I    |                                          |                                         |                                                     | Step II                                                                  |
|-----------|------------------------------------------|-----------------------------------------|-----------------------------------------------------|--------------------------------------------------------------------------|
| Test Tube | Volume of NaOH base<br>(number of drops) | Volume of HCl acid<br>(number of drops) | Color of the resulting solution<br>(pink/colorless) | Results: number of drops of NaOH base added until pink color is obtained |
| א         | 3                                        | –                                       | –                                                   | –                                                                        |
| ב         | –                                        | 1                                       | –                                                   | –                                                                        |
| ג         | –                                        | 3                                       | –                                                   | –                                                                        |

- (2 points) **ב.** Copy the two sentences below into your **answer booklet** and fill in the missing word in each sentence.

The color of phenolphthalein indicator in a basic environment is \_\_\_\_\_.

The color of phenolphthalein indicator in an acidic environment is \_\_\_\_\_.

Step 2: Learning a method for measuring the amount of acid in a solution (titration)

In the next part of the experiment, you will **gradually** add drops of a base to each of the solutions in Test Tubes ב-ג, and you will **count** the drops.

**Read the instructions in Items 7–8 before you start carrying them out.**

Work carefully and accurately.

7. Take Test Tube א out of the test tube rack and use the "NaOH" Pasteur pipette to add the basic NaOH solution drop by drop to the test tube. Shake the test tube after you add each drop. **Count the drops** until the solution in Test Tube ב remains a stable pink for 10 seconds – **the color should be as close as possible to the color of the solution obtained in Test Tube א.**
  - Put the test tube back in the test tube rack.
  - Write the number of drops that you added to Test Tube א in the appropriate place in Table 1 (in Step II in the table) **in your answer booklet.**
8. Take Test Tube ג out of the test tube rack and repeat the procedure described in Item 7 with this test tube.

Answer Question 50.

- (4 points)      **50.** Explain why each of the test tubes ב-ג requires a **different** number of drops to obtain a color similar to the color of the solution in Test Tube א.

**Put Test Tubes א-ג in the waste container.**

## Part 1 – Experiment: The effect of ethanol and glucose on the rate of cellular respiration in yeast

### Note 1

Ethanol is a substance that dissolves fats and modifies the spatial structure of proteins.

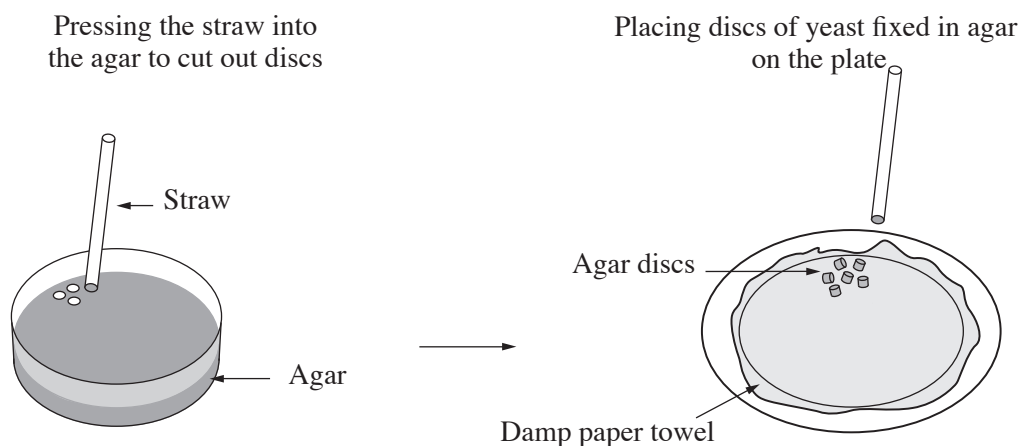
On the table, you have:

- a Petri dish with yeast fixed in agar
- a short straw
- a plate lined with a damp paper towel
- a test tube containing a 70 % ethanol solution
- a test tube containing a 0.5M solution of glucose

### Step 1: Preparing discs of yeast fixed in agar

You will be preparing discs from the agar in the dish, using a straw, according to the instructions in Item 1 below. **Read the instructions to the end and only then carry them out.**

**Figure 1:** Preparing discs of yeast fixed in agar



**Figure 1a:**  
Preparing discs from the agar

**Figure 1b:**  
Placing discs on the plate

1. Hold the straw and press it into the agar until it reaches the bottom of the dish (see Figure 1a). Give the straw a half turn, tilt it slightly, and pull it out of the agar. Note: There is a disc of agar inside the straw now.
  - Repeat the procedure two more times so that you have 3 discs inside the straw.
  - Now remove the discs from the straw and place them on the lined plate, as follows:  
Hold the straw in the middle and squeeze it with your fingers. Continue squeezing a few more times, every time moving your fingers a little further down the straw. By squeezing the straw, you will push the agar discs down the straw until they are released onto the plate.
  - Repeat the procedure until you have 40 discs on the plate.

**Note 2**

Agar is a substance with a jello-like texture that is not harmful to yeast cells. When discs of yeast fixed in agar are soaked in a solution, the agar allows the passage of substances from the external solution into the yeast cells and from the yeast to the solution.

- ז. Label four test tubes: 1, 2, 3, 4. Mark them on the upper part of each test tube, close to the rim.
- ח. Write "אתנול" on a 10 ml pipette.

Based on the information in Table 2 below:

- Use the "מים" pipette (from Part א) to add distilled water to Test Tubes 1–4.
- Use the "אתנול" pipette to add only ethanol to Test Tube 4.

**Table 2**

| Test Tube | Volume of distilled water (ml) | Volume of 70 % ethanol solution (ml) |
|-----------|--------------------------------|--------------------------------------|
| 1         | 5                              | 0                                    |
| 2         | 9                              | 0                                    |
| 3         | 9                              | 0                                    |
| 4         | 0                              | 4.5                                  |

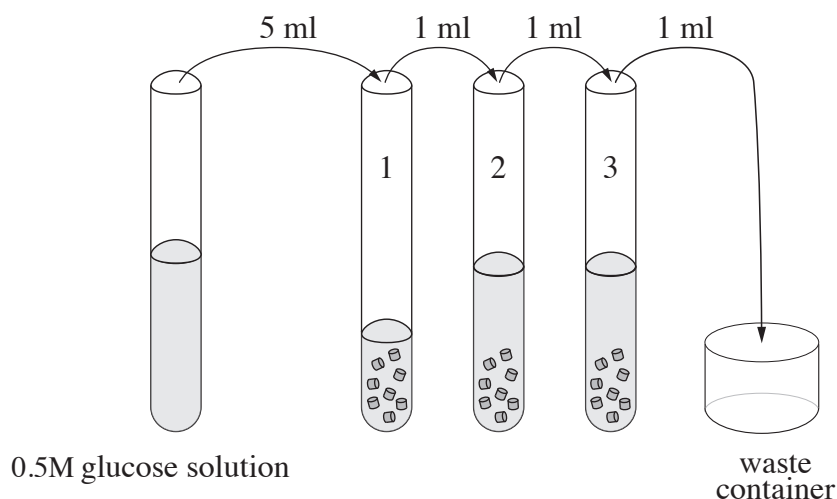
- ט. On the table, you have a container labeled "אמבט מים" [water bath], a container with tap water, a thermometer, and caps for the test tubes.
  - Ask the lab teacher for hot water and prepare a water bath with a temperature between 38°C–42°C.
  - Use tap water from the container labeled "מי ברז" if necessary. Check that the water level in the water bath reaches the line marked on the outside or inside of the water bath. If the water level in the water bath is above the marked line, pour the excess water into the waste container.
- י. Use a spoon to carefully place 8 discs of yeast fixed in agar in each of Test Tubes 1–4. Be careful not to squash the discs. Do not add broken discs (that were damaged during the preparation process) to the test tubes.
- יא. **Cap** the test tubes and put them into the water bath.
  - Write the time \_\_\_\_\_; wait 6 minutes.
  - While you are waiting, carry out the instructions in Item יב, and check that the water bath temperature remains within range, adjusting it if necessary.
- יב. Write "גלוקו 1" on a 10 ml pipette.
  - Write "גלוקו 2", "גלוקו 3", and "גלוקו 4" on three 1 ml pipettes.
- יג. 6 minutes from the time you recorded in Item יא, remove the test tubes from the water bath, shake them gently, and place them in the test tube rack.

יד. **Read the instructions in this item before you start carrying them out.**

You have been given a 0.5M solution of glucose. You will be preparing solutions with different concentrations of glucose according to the following instructions:

- Use the "גלוקוז 1" pipette to transfer 4.5 ml of 0.5 M glucose solution to Test Tube **4**. Gently shake Test Tube 4.
- Use the "גלוקוז 1" pipette to transfer 5 ml of 0.5 M glucose solution to Test Tube **1** (see Figure 2). Gently shake Test Tube 1 to mix the solution.
- Use the "גלוקוז 2" pipette to transfer 1 ml of solution from Test Tube **1** to Test Tube **2** (see Figure 2). Gently shake Test Tube 2.
- Use the "גלוקוז 3" pipette to transfer 1 ml of solution from Test Tube **2** to Test Tube **3** (see Figure 2). Gently shake Test Tube 3.
- Use the "גלוקוז 4" pipette to transfer 1 ml of solution from Test Tube **3** to the waste container (see Figure 2).

**Figure 2: Preparing glucose solutions of different concentrations**



טו. **Cap** Test Tubes 1–4 again and gently shake them to mix the solutions.

- Make sure that the numbers marked on the test tubes have not been erased and write them again if necessary.

טז. Check that the water bath temperature is kept within the range of 38°C–42°C and adjust it if necessary.

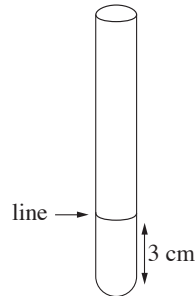
- Put Test Tubes 1–4 into the water bath.
- Write down the time: \_\_\_\_\_, and wait 10 minutes.
- While you are waiting, carry out the instructions in Item יז below and read Item יח (without carrying out any action).

Check that the water bath temperature is within the range.

זו. Label four empty test tubes: A, B, C, D.

- Use a ruler to mark a line on each of Test Tubes A–D, 3 cm from the bottom of the test tube (see Figure 3).

**Figure 3 : Marking Test Tubes A–D**



- Put Test Tubes A–D in the test tube rack in the row closest to you.
  - On the table, you have new Pasteur pipettes; label them 1A, 2B, 3C, 4D.
- זח. 10 minutes after the time you recorded in Item זו, take Test Tubes 1–4 out of the water bath and put them in the test tube rack in the following order:
- Place Test Tube 1 behind Test Tube A, Test Tube 2 behind Test Tube B, and Test Tubes 3 and 4 behind Test Tube C and D, respectively.
- זט. Use the Pasteur pipette 1A to transfer the solution from Test Tube 1 to Test Tube A up to the line marked on the test tube.
- Repeat the procedure with Pasteur pipette 2B to transfer solution from Test Tube 2 to Test Tube B.
  - Repeat the procedure with the appropriate Pasteur pipettes and with Test Tubes 3 and C, and 4 and D, respectively.

Step 2: Testing the relative amount of acid in each of Test Tubes A–D

**Note 3**

The reaction between carbon dioxide (CO<sub>2</sub>) and water forms an acid (carbonic acid).

- ג. Add 2 drops of phenolphthalein to each of Test Tubes A–D.

**Read the instructions in Item כ before you carry them out.**

- כא. Take Test Tube A out of the test tube rack.

- Use the "NaOH" Pasteur pipette to add basic NaOH solution drop by drop to Test Tube A, shaking the test tube after you add each drop. **Count the drops** until the solution remains a stable pink for 10 seconds.

**Note:** The intensity of the pink color you obtained here may be weak compared to the color you obtained in Part א of the experiment.

- Write the number of drops of NaOH base you added to Test Tube A: \_\_\_\_\_ drops.

**Note:** After you put the test tube back in the test tube rack, the color of the solution in the test tube may change; ignore this change.

- כב. Repeat the procedure you carried out in Item כא with Test Tubes B, C and D, and count the drops you add until the solution remains a stable pink – **the color should be as close as possible to the color of the solution obtained in Test Tube A.**

Write the number of drops that you added

|                 |              |
|-----------------|--------------|
| in Test Tube B: | _____ drops; |
| in Test Tube C: | _____ drops; |
| in Test Tube D: | _____ drops. |

You do not need gloves and safety goggles for the rest of the exam, so you can take them off now.

Answer Questions **51-57**.

- (6 points) **51. Calculate** the concentration of glucose in each of the solutions in Test Tubes 1–3 from Item ט at the stage when each test tube contained 10 ml of solution (before you removed some solution from the test tube).

**Calculate** the concentration of glucose in the solution in Test Tube 4 from Item ט when the test tube contained 9 ml.

Note: the concentration of glucose in the solution you transferred to Test Tubes 1 and 4 is 0.5 M.

**Write** the results of your calculations in your answer booklet.

**Provide detailed** calculations for Test Tubes 1 and 2 only.

**(Note: The questions continue on the next page.)**

- (7 points) **52. א.** Below is a list of four of the components of the experiment you conducted in Part ב. **Copy them into your answer booklet.**  
For each component write **in your answer booklet** whether it is a constant factor or a dependent variable or a method for measuring the dependent variable.  
**Components of the experiment:**
- number of drops of NaOH base required for the color of the solution to turn pink
  - cellular respiration rate in yeast fixed in agar
  - temperature of water in the water bath
  - number of drops of phenolphthalein
- (3 points) **ב.** The presence of ethanol in the test tubes is an independent variable in the experiment you conducted.  
What is the other independent variable in the experiment?
- (13 points) **53. א.** In your **answer booklet**, draw a table summarizing the experiment setup and the results. Your table should include only the following components:
- glucose concentration (Question 51)
  - volume of ethanol solution (Table 2)
  - presence of discs of yeast (Item י)
  - experiment results in Test Tubes A–D (Items כב–כא).
- (4 points) **ב.**
- Give the table a title.
  - Give a heading to each column in the table.
- (4 points) **54.** You added 8 discs of yeast fixed in agar to each of the solutions in the experiment. Explain why it was important that the number of discs **specifically** was a constant factor in the experiment.
- (6 points) **55. א.** Suggest an explanation for the results of the experiment you obtained in each of the test tubes A–C. In your answer refer to the information given in Notes 1 and 3 and also to the measurement method.
- (4 points) **ב.** Suggest an explanation for the difference between the result you obtained in Test Tube D and the result you obtained in Test Tube A. In your answer refer also to the information given in Notes 1 and 3.
- 56.** A student suggested adding a control treatment to the experiment setup – a test tube containing **only** 9 ml of water and 8 discs of yeast (with no added glucose solution).
- (4 points) **א.** Hypothesize whether the number of drops of base required to obtain a pink color in the solution taken from this test tube would be smaller than, equal to, or greater than the number of drops you added to Test Tube A (Item כא). Explain your hypothesis.
- (3 points) **ב.** Explain the importance of adding this control treatment to the experiment setup.
- (4 points) **57.** Students who carried out the same experiment you conducted (in Part ב) argued that the effect of ethanol on cellular respiration rate would be similar in all living organisms. Is the students' argument correct? Explain your answer.

### Part 3 – Analyzing the results of an experiment: the effect of ethanol concentration on yeast reproduction

Ethanol is one of the products of the fermentation process that occurs in yeast. Ethanol is very important in the wine industry, and is also used as biofuel, disinfectant, etc.

Ethanol at certain concentrations in the yeast's environment limits the rate of processes in the yeast cells, and their reproduction rate also slows down.

Many researchers are looking for a strain of yeast that can survive in an environment with a high ethanol concentration and reproduce rapidly.

#### Experiment 1

Researchers added various concentrations of ethanol to a liquid culture medium containing yeast.

They tested the reproduction rate of two yeast strains for 48 hours.

Table 3 below shows data on the reproduction rate of yeast in solutions containing different concentrations of ethanol.

**Table 3**

| Concentration of ethanol (%) | Reproduction rate of yeast<br>(relative units) |          |
|------------------------------|------------------------------------------------|----------|
|                              | Strain A                                       | Strain B |
| 0                            | 1.9                                            | 2.0      |
| 4                            | 1.9                                            | 2.1      |
| 8                            | 1.3                                            | 1.8      |
| 10                           | 0.7                                            | 1.6      |
| 12                           | 0.2                                            | 1.3      |
| 16                           | 0.0                                            | 0.5      |

Answer Question **58**.

(10 points) **58. א. (1)** What type of graphical representation is best suited to describe the results shown in Table 3 – a line graph or a bar diagram? Explain your answer.

**(2)** Draw a suitable graphical representation of the results in Table 3 in **your answer booklet**.

(6 points) **א.** Describe the results of Experiment 1, based on your graphical representation.

(3 points) **א.** **Determine** which of the two strains – Strain A or Strain B – is more resistant to the effects of ethanol. **Explain** your answer. Base your answer on the results shown in the graph you drew.

**(Note: The exam continues on the next page.)**

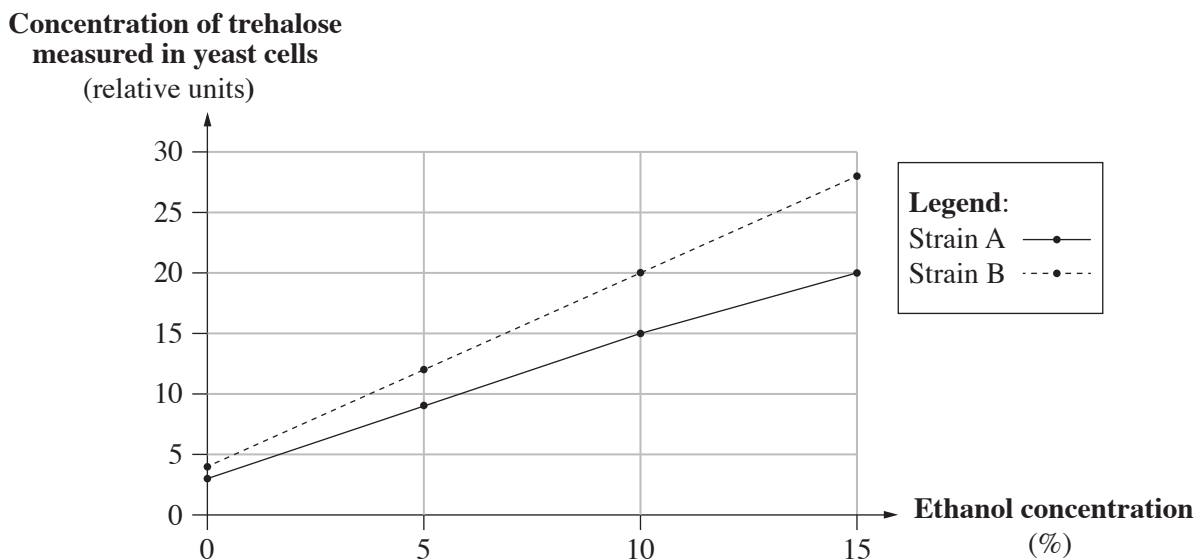
## Experiment 2

Yeast cells contain a sugar – trehalose – which serves as a storage compound. Studies found that the presence of trehalose in yeast cells protects them from the damage caused by ethanol to cell membranes and proteins.

Researchers grew yeast of both strains in solutions containing ethanol at different concentrations. After a while, they measured the concentration of trehalose in the yeast cells.

The results are shown in Graph 2.

**Graph 2: Effect of concentration of ethanol in the solution on the concentration of trehalose in yeast cells**



Answer Questions **59–60**.

(5 points) **59.** Based on the results shown in Graph 2 and the information about the sugar trehalose, explain the results for Strain B shown in the graph you drew (in Question 58).

Yeasts cells contain an enzyme that catalyzes the synthesis of the sugar trehalose from monosaccharides, and another enzyme that catalyzes the breakdown of trehalose into monosaccharides. These enzymes are active in the cell according to the concentrations of ethanol in and around the cell.

In both yeast strains, the researchers tested the activity of the enzyme that catalyzes the breakdown of the cell's trehalose into monosaccharides.

They found that in a 10 % ethanol solution, the activity rate of the enzyme that catalyzes the breakdown of trehalose was lower in Strain B than in Strain A, but the reproduction rate was higher in Strain B than in Strain A.

(4 points) **60. א.** Explain why in a 10% ethanol solution, the low activity rate of the enzyme that catalyzes the breakdown of trehalose allows a higher reproduction rate in Strain B compared to Strain A.

(3 points) **ב.** Explain how protecting the cell membrane in an environment containing ethanol allows yeast cells to maintain homeostasis.

**Give the lab teacher your exam paper and your answer booklet.**

**Good Luck!**

**בהצלחה!**